AGRICULTURAL ENGINEERING

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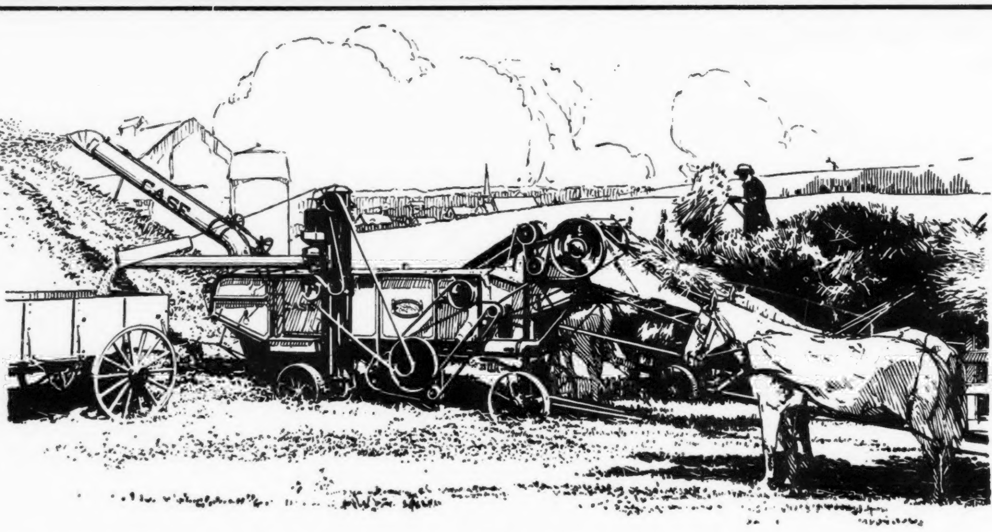

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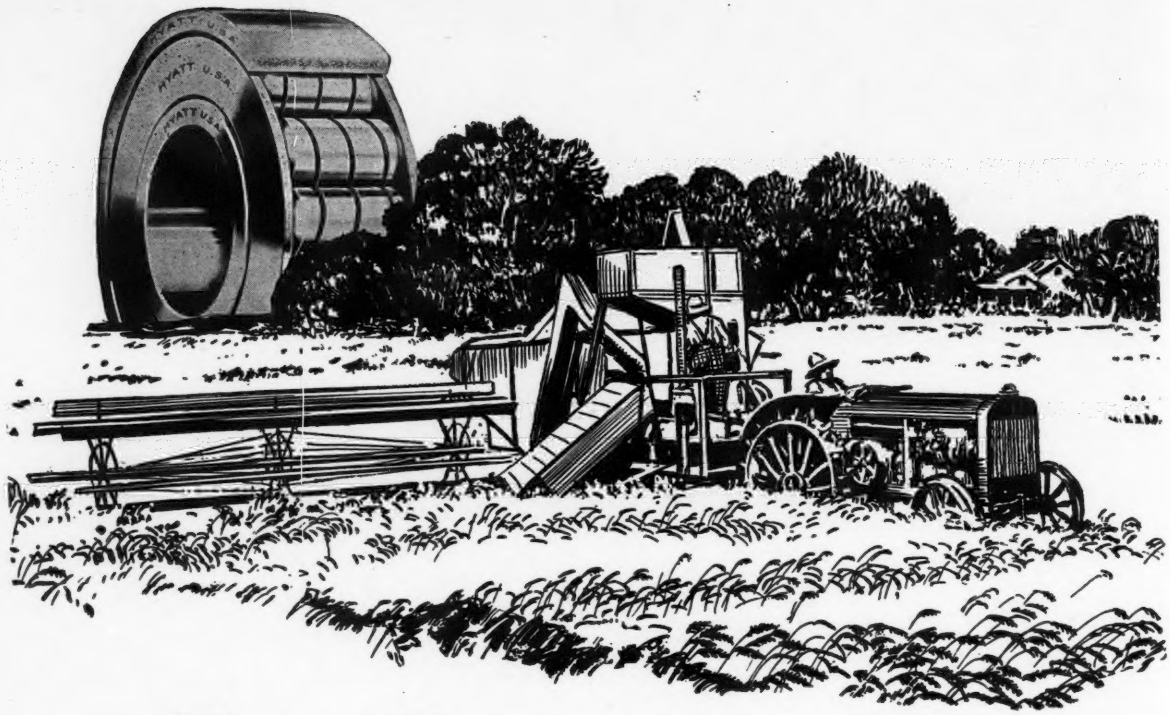


AGRICULTURAL ENGINEERING

Vol. 9 MAY, 1928 No. 5

Determination of the Basic Requirements of Farm Structures[1]

By M. C. Betts[2]

THE one phase of the agricultural industry in which there has been very little development in recent years is the shelter essential, to a greater or less extent, in all branches of the industry. Livestock must be housed, crops must be stored, various processes must be carried on in structures affording protection or providing certain requisite conditions.

Shelter and its related structural equipment have a decided influence on both quantity and quality of production directly and indirectly. It has long been recognized that the improved health, comfort and protection of stock, afforded by adequate shelter, permits of the utilization, in the production of food and materials for the use of human beings, of animal food energy which otherwise would be used by the animal in protecting itself against the effects of weather, other animals, etc. The sheltering of stock also makes for convenience in feeding and caring for them.

Agriculture has spent vast sums of money for buildings, much more than for machinery and equipment. In the future the situation may be reversed since farms are becoming fewer in number but greater in size, while the investment in equipment per worker is increasing. This change will magnify the importance, in economical production, of buildings and equipment. The farmer's time is worth more than ever before. Practically all his products have a sale value. He must have structures that will conserve his energies in operation and his products. The kinds of materials available for new buildings are numerous, the initial investments are greater and the requirements of efficient management are more complex.

Yet the farm buildings of today differ but little from those of fifty years ago and, except in a few respects, from those of a much earlier age. The growing scarcity of large timbers and the recognized advantage of a clear mow compelled the adoption of new methods in barn framing. The necessity for cleanliness in disease prevention brought about the adoption of concrete flooring and other sanitary measures. Tighter and warmer construction was adopted in cold sections because it was found that the greater comfort of the animals resulted in increased production. Certain inventions of equipment which reduced labor have been adopted quite generally.

Shelter, as we have it today, must be credited with good results, for it has contributed to the increased quantity and quality of production which has taken place, but the cry in every direction is for greater efficiency and lower cost of production, and farm structures must be made to contribute to the effort being made to bring this about in the agricultural industry.

It is said that our farm buildings, some of them at least, cost too much; that the interest on the investment and the carrying charges bear an undue relation to other items of production costs. It may be so, but who can say what is or is not a proper relation. If, in a manufacturing process, certain very expensive equipment is necessary, its cost may bear a high but not undue relation to the other items of production cost. The substitution of less expensive but equally efficient equipment will always be sought, as a means of lowering production costs, but until that has been accomplished the relation stands and may even be increased as other items of production cost are reduced.

It is the same with farm structures; a building with its equipment may be fully essential to the greatest efficiency and production and be chargeable with a seemingly high percentage of the total cost of production. The percentage may even be increased, with respect to a dairy barn, for example, by a lowering of other cost items through improved feeding, breeding, management, etc. But whatever the relation of building costs to total production cost we must endeavor to reduce the investment in shelter.

The question may well be asked: Wherein do our farm structures fall short? A definite answer may be possible with respect to a specific structure or function of that structure. In respect to others the answer must be: We do not know because we do not have a measure of performance, that is, definite knowledge of the requirements and means of determining the extent to which requirements are met.

[1]Report of the Committee on Research Development presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, at Chicago, December, 1927.

[2]Architect, Division of Agricultural Engineering, U. S. Department of Agriculture. Chairman, A.S.A.E. Committee on Research Development. Mem. A.S.A.E.

Shelter, as we have it today, must be credited with good results, for it has contributed to the increased quantity and quality of production which has taken place, but the cry in every direction is for greater efficiency and lower cost of production, and farm structures must be made to contribute to the effort being made to bring this about in the agricultural industry

We know, for example, that the roofing used on most farm buildings constitutes a fire hazard that should not exist yet, because of the low cost, such roofing is and must be used. There is a problem in the development of a fire-resistant roofing material that shall not cost more than commercial prepared roofing.

The concrete floor, so widely employed in stock shelters, is a great improvement over earth or wood floors and, for most purposes, is perhaps the best that can be had, but for some uses it is not entirely satisfactory, and there is the question whether or not it can be improved, with respect to certain characteristics, or whether some other floor can be developed.

We know that storages for certain crops are by no means entirely successful because there are heavy losses in storage. We do not know the remedy because we do not definitely know the conditions under which the crop must be stored for best results.

We do not know wherein our dairy barns may be at fault because we do not have definite information as to the requirements to be met—the temperature, humidity and other environmental conditions making for greater production of milk. We do not know what arrangement, under varying conditions of location, climate and practice, makes for greatest efficiency in management. We do not know which of several types of barn roof framing in common use is the most economical. We do not know to what extent steel can be used to advantage in barn framing. We do not know whether the cost of producing and maintaining, within the barn, conditions which have been or may be found conducive to increased production is warranted. We do not know the value of some of the barn equipment in use—under what conditions of size of industry and practice it may be warranted as an economic measure.

A similar lack of information exists with respect to other farm shelters and before we can proceed to reduce construction costs we must have the knowledge, the lack of which has just been indicated, and a great deal more. We must know the conditions that must be provided for and the requirements which make for inceased production or a saving of labor must be shown to be worth the cost of meeting them.

As further evidence of the need of research in farm buildings it may be stated that, owing to the public demand for information, nearly 30 per cent of our agricultural-engineering extension workers devote their major efforts to farm structures and most of them have had to develop their subject matter from existing common practices since practically no research of a basic nature has been done. According to a rough estimate, made by one of your committee, six times as much effort is being placed on extension work as on research. If there is to be progress in farm structures, this ratio must be changed so that the extension worker may be supplied with proven facts which he can pass on to the farmer.

In their broad aspects the research problems with which we are confronted may be divided into two classes—those involving the determination of the requirements in structures making for greater productiveness and efficiency and those involving the determination of the means by which the requirements may be met.

Some of these problems are comparatively simple in that the solutions lie in single or small groups of determinations; others are of a highly complex nature involving a number of factors. Some are strictly engineering problems, others are of an engineering-economic character, others, in the determination of requirements, will require the cooperation of animal husbandry, crop or other specialists.

Some of the information which is lacking will, when obtained, apply to structures in general or a particular kind of structure in all or most sections of the country, as in the case of fire-resistant roof covering which is needed on practically every farm, or an improved type of hay door applicable to any hay mow. Some of the results of investigation will have more or less limited regional application; for example, findings relating to the storage of rice which is grown in but a few localities.

The information required in the process of designing any given structure and its equipment may be classified under the following heads arranged in the order in which the data would be needed; all of the data indicated would not be needed in the designing of some buildings and, with respect to certain structures, some of the necessary information may be already available though not generally known

Space Requirements. The need of this information is obvious as it fixes or is the basis for the determination of total dimensions. The unit space requirement in some instances is fixed and known; in others an average size must be used because of lack of standardization as in the case of certain containers or because of variations due to condition as in the case of loose hay. There are differences of opinion as to the proper space allotment for various kinds of stock. Obviously climatic conditions would have a bearing on the question but, until the optimum space requirement has been definitely determined, there is the possibility of a saving in space allotment. If the space per head generally allotted to cattle can be reduced but slightly, without affecting the production or convenience in handling a material, total saving would result—similarly with hogs, sheep, poultry, etc.

If hay could always be stored in bales a very considerable saving in storage space could be made. At present there are limiting factors but harvesting methods may possibly be so improved as to permit of storing in bales.

Arrangement for Efficiency and Economy. The location of a given building with respect to other buildings, fields, lots, roads, etc., and of the various fixed features of construction and equipment within the building to each other has a decided bearing on the time and labor involved in the performance of operations and consequently on production costs. In order to design for the greatest efficiency and economy we must know the best arrangement and to learn this means analysis of the relationships pertaining to each building with the variations incident to type of farm, climatic and other regional influences.

Temperature. In certain structures protection from low temperatures must be provided; in others high temperatures must be guarded against. Unless the optimum temperature, or range of temperatures required, is known together with the amount of heat available for maintaining temperatures above that of the outside air the refinement of design essential to dollar saving is not possible. Insulation costs money and when used unnecessarily increases the cost of production. It is also true that lack of insulation costs money through loss, or lowered quality of product.

By providing a liberal amount of insulation the necessary protection may be had, but that is not only wasteful but poor engineering. In certain instances we know the optimum temperature to be maintained but do not know the amount of heat available; in other instances there is lack of agreement as to the optimum temperature. Where temperature is a factor more accurate knowledge of requirements is needed.

The maintenance of temperature, in certain farm structures, must be accomplished by ventilation. Ventilation may be had by mechanical means, where electricity is available, or by the employment of natural forces. Whether mechanical ventilation can be had more economically than natural ventilation is a matter to be determined. The question of when, where and to what extent ventilation is essential to economical production affords a broad field of investigational activity.

Humidity. As a factor in environmental conditions affecting crop and animal production and in the preservation of structural materials, humidity is of great importance. As in the case of temperature, with which it is intimately related, there is an embarrassing lack of knowledge as to requirements and economical methods of control.

Ventilation. The optimum conditions of temperature and humidity having been determined, the factors governing the maintenance of such temperatures and humidities must be determined. Obviously, if temperature and humidity control is essential, it can be accomplished only through the use of insulation and ventilation whether natural or mechanical means are employed. In either case there is much to be learned with regard to temperature and humidity control in farm buildings.

Light. Light is essential to the efficient performance of indoor operations and especially from the standpoint of sani-

Agriculture has spent vast sums of money for buildings, much more than for machinery and equipment. In the future the situation may be reversed since farms are becoming fewer in number but greater in size, while the investment in equipment per worker is increasing. This change will magnify the importance, in economical production, of agricultural buildings and equipment

tation and the health of the animals. More definite knowledge is wanted as to the optimum amount, kind and location of light, both natural and artificial.

Sanitation and Water Supply. Anything less than is now recommended by way of sanitation measures is not to be thought of since sanitation has a decided bearing on production, both directly and indirectly, but it is quite possible that the results sought can be attained by less expensive means. The installation of adequate water supply systems affords a similar field of investigative effort.

Selection of Materials. Having the necessary data falling under the preceding heads, the next step in design is the selection of materials. In many instances there is little or no choice as in the case of temporary or certain unimportant structures. In the more important buildings, depending upon locality and use, the choice of materials involves a number of factors including availability, cost, suitability for purpose, durability, maintenance, preservation, fire resistance. Data are available with respect to the characteristics of some of the materials that might be employed but in order that a choice may be made on a sound economic basis much investigational work is necessary. The development of new materials or new uses for known materials affords opportunities for valuable research.

Structural Design. In the designing of the actual structure, that is, the putting together of the various selected materials, common local practice is the usual guide. Practice varies with the locality. Precedent is a potent factor. Because of ignorance of requirements, strength of materials or engineering principles, the designers of some of our existing buildings built safely by employing considerably more material than may have been necessary—others, for the same reasons, produced buildings that have failed structurally.

We have arrived at a point where the strictest economy in every detail of structural design is essential. By economy is meant the least material and least labor consistent with the requirements for strength, durability, purpose, etc. A great deal of engineering data, applicable to the design of farm structures, is available. There is much lacking, either unknown or not in readily available form, such as unknown stresses, unknown strengths, as of various joints. Common practice can be improved—at least the best of common practice can be determined and brought into more general use. Common engineering practice provides for a large factor of safety—to what extent may this be modified? Considering the fact that failure of a farm building involves less chance of life or community property loss, a lower factor of safety may be entirely warranted.

Equipment. Various kinds of equipment, used in connection with farm buildings, are intended to save time and labor. There is the possibility of improving the design of some of this equipment so as to increase its efficiency or reduce the cost, or both. There undoubtedly is a limit of size of farm industry or operation below which some of the equipment in use is not economically warranted. Where such equipment is included in the cost of the building it bears out the charge that our buildings cost too much. The economic value of each item of equipment, which may be considered a part of a farm building, must be proven.

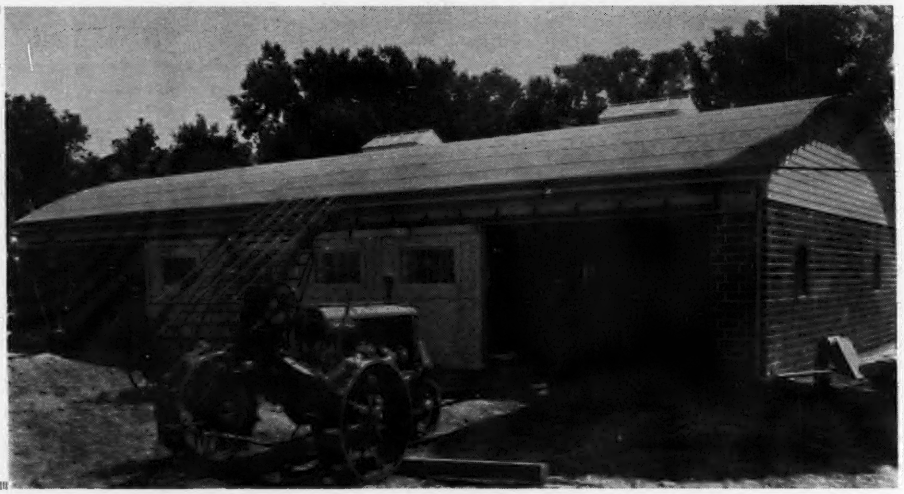
PROGRAM OF INVESTIGATION

We come now to the crux of the situation—where and how to attack this problem of research. We know what is needed —how can we obtain it? Obviously it cannot all be done at once—it means years of work. It will require the earnest effort of individuals and groups working independently and cooperatively. There are problems the solution of which may be of very pronounced effect but which will require time and expense beyond present possibilities. There are others which may perhaps be solved in a comparatively short time but which are of minor importance. A start must be made with the means and material already available for it may be taken for granted that greatly augmented funds and personnel will not be had for the mere asking. That, however, need not prevent the asking, but in making the request we must base it upon a definite plan of procedure.

Taking stock of our present means we have a very few state agricultural experiment stations where research work in structures is possible. With a definite program of work to be done it may be that other of these stations will find it possible to provide one or more men qualified to carry it out, if they can find them. If none are available they must be trained, affording an opportunity for more of the agricultural-engineering departments to add to their usefulness. Part of the training could consist of research, as is now the case in some of the departments, but as a part of a general or national program. Just how the building up of personnel can be brought about remains to be worked out but, with the right influences set in motion, it should be possible to improve the situation.

In planning a comprehensive program it seems but logical to begin at the beginning. In other words, to follow, in our seeking for information, the natural sequence in the designing of a structure as indicated in the preceding classification of information desired. It also seems reasonable to confine our major efforts, as far as possible, to the development of information pertaining to buildings for some one purpose such as the dairy barn, so that complete information on that subject may be had as soon as possible. The work on dairy barns would be carried on only in those sections in which dairying is an important industry. In those sections wherein dairying is of minor import, some other kind of shelter would be investigated.

Since in several of the colleges research investigations are now in progress, effort should be made to make such work a part of the general program, modifying or amplifying the projects as may seem advisable. As existing projects which



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fall under the later steps of investigational sequence are completed, new projects relating to the earlier steps would be set up. As the various investigations are completed and the results brought together a fund of information on farm structures would be built up. Much of the information relating to one type of structure will be applicable to others so that if the information is properly compiled as obtained, progress in structures research should be more rapid than may now appear possible.

Obviously there will be differences of opinion as to the kind of structure or structures that should be investigated first—just as there will be differences of opinion regarding this whole proposal. Both are subject to discussion and revision. It is extremely doubtful whether any proposed program will meet the unqualified approval of all concerned. If this movement is to meet with any degree of success, discussion and criticism must be tempered with open mindedness and sincere desire to help.

It is suggested, then, that there be set up a series of projects designed to bring out the desired information beginning with dairy structures and following with housing and equipment pertaining to poultry, swine, beef cattle, grain, fruit and vegetables, or in whatever order may be decided upon. These projects would be carried out by single institutions or by cooperative arrangement between two or more institutions depending upon the nature of the problem.

The development of the whole program would be guided by the active leaders of each project through their respective heads and in conjunction with a central correlating agency such as the Division of Agricultural Engineering of the U. S. Department of Agriculture.

No attempt has been made to work out detailed project statements. The general idea would be as exemplified in the following general outline of the first of a group of projects dealing with dairy barns, with such modifications as may be found necessary or desirable. Succeeding projects would carry subtitles and object statements indicative of the purpose, namely the obtaining of data relating to requirements and methods of meeting them and would be set up in the order of the classification previously suggested until the ground relating to dairy barns has been covered. Projects relating to other structures would follow or possibly be set up simultaneously.

Project No. 1

INSTITUTIONS:

DEPARTMENTS: Animal Husbandry (Dairy). Agricultural Engineering.

TITLE: Dairy Barn Requirements and Methods of Meeting Them

SUB-TITLE: Determination of Space Requirements

OBJECT: To establish the minimum unit space requirements consistent with the welfare of the stock and convenience in operation with respect to stalls, gutters, mangers, alleys, cow pens, calf pens, driveways, feed storage, ceiling heights.

PROCEDURE:

1. To review all available data recording that which is based on competent evidence.
2. Field studies of selected existing barns recording space dimensions with observations of owners and investigators as to reasons, effects and related factors.
3. Analysis of all data to determine the minimum allowable dimensions under varying conditions of practice, climatic and other essential regional influences.
4. To check findings by means of experimental installations under controlled conditions.

ORGANIZATION AND COOPERATION:

This project would be conducted under the auspices of at least three agencies located respectively in the northern, southern and western dairy sections of the country and the U. S. Department of Agriculture, so as to bring out variations in requirements due to location, climate, differences in practice, etc.

Direction would be by a committee of leaders appointed from each agency. The leaders in each state institution would be appointed, one from the department of animal husbandry (dairy) and one from the department of agricultural engineering.

The department of agricultural engineering would be responsible for the recording of physical conditions and the factors affecting them.

The department of animal husbandry would be responsible for the recording of the condition of the stock as affected by the physical environment under consideration.

The two departments of each institution would be jointly responsible for the analysis and checking of data obtained in the respective regions and the preparation of a report thereon.

The committee of leaders would be responsible for the preparation of a combined report making recommendations of space requirements.

Under the head of procedure, in most instances at least, the first step would of necessity be of the nature of a preliminary survey in order that there may be understanding of the various factors and practices that have become established empirically. This preliminary work would consist of careful reviews of all available data and field surveys to determine the best of recognized practices. Then would follow, where necessary or desirable, experimental or other form of research to determine basic facts.

The details of the method of approach and the data to be secured will have to be worked out for each project, but in each case of cooperation in which two or more agencies are engaged in obtaining the same kind of data, a predetermined line of inquiry and basis of measurement must be observed by each investigator so that all data obtained will be comparable.

There are of course many details that will have to be worked out but your committee feels that it is only by some such coordinated cooperative effort that any degree of progress can be had in the development of farm structures.

Discussion

FRANK P. CARTWRIGHT[3]: There are a number of considerations which are important both to the durability and servicability of frame buildings, whether for farm use or for other purposes, and which, as pointed out by Mr. Betts, contribute directly or indirectly to economy, that most essential characteristic of farm practice at present. Among these characteristics are durability; resistance to heat transmission, both from the viewpoint of storage and winter comfort; fire

[3]Chief engineer, National Lumber Manufacturers Association. Mem. A.S.A.E.

resistance; strength and rigidity, particularly as regards tornado resistance; and many other factors which are more or less important, depending on locality and purpose.

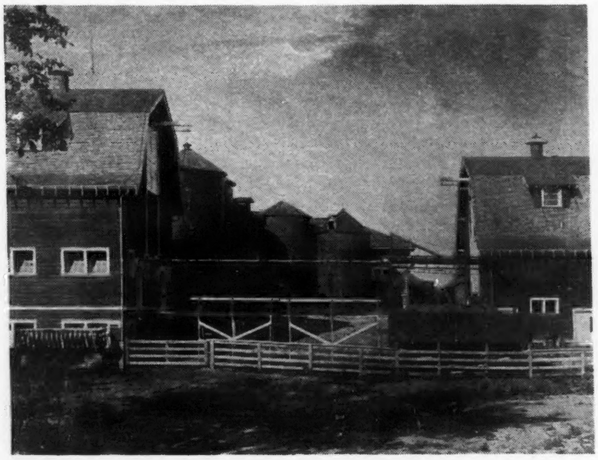
As regards durability, comparatively little research appears to be necessary. There is a sufficient volume of experience with lumber in construction to show that when protected from moisture its permanency is practically unlimited. There is, on the other hand, clear evidence that, in the absence of such protection, decay and in some localities other types of damage will result. We know this qualitatively, so to speak, but not quantitatively. A field investigation which will afford quantitative bases for an authoritative statement on decay hazards and their elimination will go far toward improving the durability of farm structures.

Another feature affecting serviceability and durability of frame buildings is the control of moisture content in lumber used for construction. We know that unsatisfactory buildings result from the use of green lumber. We do not know so definitely the maximum moisture content which lumber may have and still result in a thoroughly satisfactory and serviceable structure. This can be determined in large measure by an investigation of the range of moisture content in lumber actually in use. We know that this range is far less than is popularly supposed, but we are not yet in a position to state even approximately what it is nor the original moisture contest which in connection with this range will afford the best results.

Paints and painting methods constitute another subject which will richly repay investigation. Previous investigations of paint have centered around the appearance characteristics of the coatings. This is by no means unimportant. From an economic viewpoint, however, and in some farm structures particularly, the protective properties of paint are even more important. There is ample evidence in partial or small scale investigations already made that the protection possibilities of paint can be increased 100 per cent at least with very little or no increase in cost. The possibilities indicated by these preliminary investigations should be followed out thoroughly.

As regards the strength, stiffness and other mechanical properties of lumber, little additional investigation is necessary. These are matters well known to the wood technologist, and it requires merely a thorough campaign, in which the members of the American Society of Agricultural Engineers and the agricultural extension men throughout the country can be exceedingly effective, to interpret this information in a form useful to the farm builder. There are possibilities in the use of high-grade timber by which greater strength is secured at very little increase of cost, which should be of particular interest to those erecting large barns or other structures involving timber strength.

Possibilities of greater fire resistance of farm structures are receiving much attention, both from the National Fire



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Protection Association and other insurance groups and from those directly concerned in farm affairs. Here again the possibilities of prevention are fairly well known and it remains only to secure general practice in their application. Firestopping, high-grade wood shingles, or roofings of asbestos, slate or other strictly non-combustible materials are available. One possibility in this connection which should be more thoroughly canvassed is the use of fire-retardant treated lumber. Several processes have been developed by which lumber is made materially more resistant to fire attack. The practical possibilities of these treatments should be canvassed and further work done to improve them if improvement is possible.

The frame building more than any other type lends itself readily and conveniently to fuel economy. Lumber itself in its commercial thicknesses compares favorably with many of the so-called insulating materials as an insulator. We do not know, however, the insulating capacity of many of the lighter and more effective species such as are used in various parts of the country for sheathing, siding, shingles and other structural parts; and we do not know the insulating capacity of the lighter grades in the heavy dense structural species. This is a matter with which the lumber industry is concerning itself promptly, and it is expected that more complete information on the subject will be available in the near future.

Speaking now of the general program of research outlined by Mr. Betts, it appears that the farmer or his advisors in the personnel of the American Society of Agricultural Engineers and other similar groups must put his requirements for space and serviceability in as definite terms as possible. When this has been done we must look around us and select on the basis of complete information where available or through additional research where necessary, the character of construction and materials which will most nearly meet these requirements. The lumber industry stands ready to do its part.

H. B. WHITE[4]: A specialist in animal husbandry who has given much time to research was approached with the request for a cooperative project to determine the optimum housing condition for pigs. The reply was that it was difficult to use animals as measuring standards for housing conditions. But this same specialist feeds different rations, and by using a number of animals he neglects the shelter as a possible variable and makes very satisfactory conclusions along feeding lines.

About thirty-five years ago plant breeders at the University of Minnesota began using a method called the "centgener method." The name came from using one hundred plants in a test bed and was successful largely because of the clever machine which made it easy to plant ten seeds at a time. The machine was invented for the purpose. Although agricultural engineering was not known as such at that time, one of the charter members of the American Society of Agricultural Engineers was largely responsible for the development of the machine. He was blushingly forced to admit about a third of a century later that he was instrumental in the development of plant breeding.

Farm management studies have lead to a great deal of emphasis being placed on the fact that nearly one-fifth of the farmer's investment is in buildings, the amount varying according to the type of farming carried on in each particular case. It was pointed out by Mr. Betts that this may not be unduly high when the importance of good shelter in the operation of the farm business is considered.

The development of farm structures will always appear slow and conservative as compared with the development of automobiles. The longer length of life of buildings will always make the average building more out of date than is the average automobile which has a life of a few years only. Buildings are built only once in one or two geenrations and will not average so up-to-date as will such equipment as automobiles and binders which are replaced every few years. It is not correct to say that farm structures are not being improved.

It is unnecessary at this time to name the problems in farm structures as the list of suggested research problems relating to farm structures that has been prepared is very

[4]Agricultural engineer, University of Minnesota. Mem. A.S.A.E.

complete. Copies of this list are available in many of the offices of the farm buildings men of the agricultural colleges awaiting time and money that the problems outlined may be tackled and solved.

As has been pointed out there are obstacles in the way in carrying on research in farm structures, but they would be quickly overcome if the men were not busy with other duties. There is more research being done than may at first appear. The list of projects in farm structures now in progress, which was distributed at the same time as the list of suggested problems, includes one hundred and twelve projects. This number shows that the opportunities in research are not being neglected. There is of course room for more work to be done along this line, and if the commercial organizations could help the building men in the state institutions to convince the powers that be of the importance of farm structures work and the need for more research and publicity in this field, they would be doing a good piece of work.

It is important that farm buildings be a good investment and adopted by the farmer as rapidly as possible, if agriculture is to benefit in the near future from the skill of the manufacturer of modern building materials and the ingenuity of the architect and engineer. The farmer, the manufacturer, the architect and the engineer are anxious for the research worker to furnish facts so that better farm buildings may be made available.

C. S. WHITNAH[5]: One splendid feature of Mr. Betts' outline is that the answers to the problems which he presents must be in terms of economic propositions.

It must be recognized that the answer to questions raised by Mr. Betts, such as the optimum conditions of temperature and humidity in a stable, must be applied to the housing of animals of varying degrees of economic productivity. When Mr. Betts' question is answered, the agricultural engineer will be in a better position to design efficient farm buildings.

Another advantage of his classification of the features of farm structures is the fact that the results of the research which we are confident will be carried on will be applicable to all parts of the country. The action of this meeting regarding the program recommended by Mr. Betts should be one which will help to put it in operation.

It is obvious that something besides a program of research and the conduct of certain research projects is needed to bring about the results he has outlined. What we need is a centralized management of all of these projects, one which has ability to direct each in relation to the others. We may hope to some extent to obtain aid from the U.S.D.A. Division of Agricultural Engineering, but we have no right as the American Society of Agricultural Engineers to let our efforts stop with such a plea.

The members of one national engineering society facing the need of definite research financed a considerable amount of research work by a membership assessment, until enough progress had been made that subscriptions could be secured from commercial interests who could see the benefit of the results to their business. The building up of our society finances and the activities of our Secretary's office can be greatly helped by the publication of research information which will make AGRICULTURAL ENGINEERING a worth while magazine for an increasing number of readers.

The fact must be borne constantly in mind that, if we are to justify a program of research involving the expenditure of a considerable sum of money, we must be able to promise practical economic utility to those who are to provide the money.

Referring again to Mr. Betts' classification, the arrangement of farm structures for convenience and efficiency is a subject which interests many manufacturers of equipment and general information which would put their sales efforts on a sound economic plane would form a basis on which to appeal to them for money.

Temperature and humidity influences in farm structures is a subject which warrants an appeal to commercial interests dealing in building materials, insulation and heating and ventilating equipment. The influence of light in farm structures is another field of research which warrants an appeal to the manufacturers of glass, windows, etc.

The other two classifications—the selection of materials and structural design—are fields which may yield a great deal of valuable information.

In view of the large number of state experiment stations and commercial laboratories which are already working on these problems, it does not seem logical for the American Society of Agricultural Engineers to start building, equipping and manning new laboratories.

It does appear that it is time we put forth some definite effort to the correlation, direction, and promotion of such a program as that proposed by Mr. Betts.

[5]Chief engineer, King Ventilating Company. Mem. A.S.A.E.

GEO. L. BENNETT[6]: Design of buildings cannot proceed rationally without fundamental data. And fundamental data will not be developed by research unless it appears that a substantial reward will result in the form of a sufficient saving on building costs or of savings in labor in the use of the new type of building, or profits from better products coming out of such buildings.

One requirement of research is reward. If reasonably definite belief of large reward from researches can obtain general acceptance, we can rest assured that the fundamental researches will develop rapidly.

Here, however, is the sticking point. Sufficient reward is not assured and research therefore lumbers along with a bundle of paper instead of a bundle of hay ahead of its nose.

The way around this lies in two facts. First, that the whole subject of design of any farm building cannot properly be regarded as a design for a set condition but as one for a condition of variation and growth. If it is a dairy barn the number of cows milked varies often with the season and with the farmer's success, the kinds and bulks of feed vary from season to season, weather conditions change, etc. In brief, the design has to recognize a number of conditions other than those of the optimum operating conditions. Consequently all the factors which enter need to be weighted with their relative importance under each of a few most usual general conditions and also the design made to conform to these rather than a single set of optimum conditions. In the course of such weighting of factors, many of these factors become unnecessary to determine for the ordinary case and thus the research is reduced and more reward is left to attach to such as must be made.

And, second, that many facts now available have not in the design of ordinary or usual farm buildings been applied with the economic skill which would be used in a number of branches of large industrial engineering, such as foundry buildings, steel plants, blast furnaces, terminal grain elevators, slaughter houses, refrigerating warehouses, etc. This is no criticism of the agricultural engineer. The problem has been too scattering, the conditions before careful weighted analysis seemingly too many, the rewards apparently too few.

Times change. We approach swiftly a condition of general public acceptance of less individuality and greater standardization where sufficient gain results from the surrender.

The thought I would bring to you is that the Structures Division of the American Society of Agricultural Engineers need not await the researches of the various branches of agriculture with folded hands or with hands raised only in entreaty, but can by a skilful utilization of the factors now available prove to the powers that be in agriculture that sufficient rewards do exist to well repay as a first step very active research into the most important underlying factors governing farm building design, and that nothing will do more to provoke research on necessary points than a putting forward on the part of the structural agricultural engineer of the best solutions possible to the building question possible from a skilful analytical use of existing data.

To a great extent this seems to be a subject which can best be handled by the process used for the development of the Liberty motor during the late war, closeting together several of the best qualified designers for the short time necessary to produce the main outlines, details, and specifications of the major designs.

[6]Engineer, Sheet Steel Trade Extension Committee. Mem. A.S.A.E.

The Agricultural Engineering Programs at the Agricultural Experiment Stations

By R. W. Trullinger[1]

A PERUSAL of the programs of investigation in agricultural engineering at the state agricultural experiment stations, made with the cooperation of agricultural engineering departments and experiment station officials, indicates that considerable systematic reorganization of the work has been taking place at some stations, which has resulted in the quiet extensive elimination of superficial and unproductive work. While in other instances the pruning process does not appear to have been quite so severe as yet, in the majority of cases there is an evident tendency on the part of station administrators to discard the weaker projects, and where possible, to replace them with stronger work. Where stronger projects have not been forthcoming, the natural result of this pruning process has been to reduce materially the total number of active projects in some branches of the subject.

It seems reasonable to expect that, since the elimination of the weaker work has been extensive in some cases, it is likely also to occur in other cases. While quality in the work is undoubtedly the most important consideration, there is some strength to the argument that quantity of active work is to a certain extent an indication of the amount of recognition and support it receives. It seemed advisable, therefore, to examine the present program in the light of accepted research standards in order to learn something of the possibility of its being further reduced and to be in a measure prepared to intelligently fill the resulting gaps with sound undertakings.

The agricultural engineering program was therefore considered, so far as possible, in the light of the report of the Committee on Experiment Station Organization and Policy of the Association of Land Grant Colleges relating to the outlining of research projects. That committee recommended, to research workers and administrative officers, the more careful scrutiny of projects, keeping in mind among other things:

1. The title, which should characterize the concrete, limited unit of work to be undertaken and not cover the entire field to which the project is related
2. The objective which should be clear cut and specific
3. The outlook which should take account of the status of the question, attack points which need further study, and indicate specifically what it is proposed to add to the sum of knowledge of the subject.

The following information, while of necessity quite general, should contain a few points of interest to workers in agricultural engineering and should suggest lines along which intelligent revision of some of the work in the subject can be undertaken if necessary:

Number of Projects. The work in or closely related to agricultural engineering now in progress at the agricultural experiment stations numbers 282 projects, so far as could be determined from all sources. These are distributed among the different branches of the subject about as follows: Machinery, 90; structures, 49; irrigation, 30; drainage, 26; sanitation, 16; electrification, 29; materials, 22; land clearing, 11; soil erosion, 5, and miscellaneous, 4. However, of this total number there are 22 projects which, while bearing closely on agricultural engineering, are in reality being conducted by other departments of the stations concerned. There are 8 projects in machinery economics, for example, which are being conducted by economics departments. This, therefore, reduces the total number of projects in which agricultural engineering departments are actually participating to 260.

Stations Participating. Forty experiment stations in 39 states are participating in this program. Of these, six apparently do not have agricultural engineering departments, and the work, numbering some 7 or 8 projects, is being done by other departments of the station.

The striking feature of this program is that over 60 per cent of the strictly agricultural engineering projects are being carried by only 10 stations, and over one-third by only 4 stations. This indicates that the burden of the work, so far as numbers of projects is concerned, is being borne by a relatively small number of stations. It also suggests that the facilities of some agricultural engineering departments are spread over a large number of projects. The latter is borne out by the fact that two departments report 25 active projects each, one 24, and one 19. It is interesting, therefore, to note the nature of some of the work, as indicated by the titles.

[1]Assistant in experiment station administration and agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture, Washington. Mem. A.S.A.E.

It seems quite evident that the activities of the Advisory Council on Research in Mechanical Farm Equipment have had a markedly favorable influence on research in farm equipment problems

Machinery. The 90 projects in machinery are at 27 stations. Of these, 35 are being carried by 5 stations. These projects may be classified as follows: General projects, 5; tractors, 11; horse motors, 3; tractor economics, 6; harvesters and threshers, 14; tillage machinery, 8; seeding machinery, 4; power requirements, 10; machine draft, 6; crop drying equipment, 9; and miscellaneous machinery, 14.

The general machinery projects appear to be surveys, for the most part. "Farm Machinery Survey" is a typical title. The studies in tractors and tillage machinery include some of a highly fundamental character which have been in progress for some time, notably those at the Alabama and California stations, for example, which have been reported on from time to time. However, the former subject also includes 5 projects on tractor testing and tractor surveys, which type of project constitutes nearly half of the total. The projects on power requirements include, among others, the power and labor studies at the Pennsylvania station and the belt-driven machinery studies at the Wisconsin station. The 6 projects on tractor economics are being conducted by economics departments but are naturally of interest to agricultural engineers. The studies of crop-drying equipment, while new, are quite important and fundamental for the most part, and have yielded some valuable results. The studies at the Illinois and Wisconsin stations on corn drying, at the Kansas station on hay drying, and at the California station on fruit drying, are notable examples. The work with harvesters and threshers seems yet to be somewhat general and indefinite, owing to the fact that it is new and somewhat uncharted. However, it promises to become more fundamental as the ground for study becomes more clearly defined and the identities of important specific problems are established.

The entire program of machinery investigation, while it seems yet to include much of a general nature, appears to have greatly improved during the past two years. The more general and superficial work is evidently gradually giving way to the more specific and fundamental in many of the branches as the fields for specific investigation become more clearly defined. This is due in some considerable measure, of course, to the natural development in the subject. It seems quite evident, however, that the activities of the Advisory Council on Research in Mechanical Farm Equipment have had a markedly favorable influence all along the line. The fact that so much improvement has occurred since that council was appointed speaks well for this important move. The reports of that council suggest, however, that the quantity of work now active is yet entirely inadequate, in view of the many pressing problems existing in the subject.

Structures. The program of work in structures comprising 49 projects is operative at 19 stations. One station has 13 projects in the subject and the nearest competitor out of the remaining 18 stations has only 4 projects. This would suggest that with that one exception the work is rather well distributed among the stations active.

The active program of work in structures may be classified according to subjects and numbers of projects as follows: General projects, 9; ventilation, 10; dairy structures, 9; poultry structures, 4; silos, 4; swine structures, 5; storages, 3, and miscellaneous structures, 5. Ventilation and dairy structures seem, therefore, to offer the most important farm structural problems at this time, if the amount of investigational work scheduled in these subjects is an indication of their relative importance.

It may be interesting to note that of the 10 ventilation projects, 6 deal with the ventilation of poultry houses and include the highly fundamental controlled study of the air requirements of poultry being conducted at the Iowa station. The remaining four projects deal with the ventilation of dairy barns. The fact that the projects in ventilation, dairy structures and poultry structures number nearly half of the total structures projects would seem to be quite significant.

It is to be noted that the 9 general projects in structures are entitled "Farm Buildings" or "Farm Building Plans." Of the 9 projects in dairy structures, 4 deal with the general subject of dairy buildings, while the other 5 deal with some specific feature of dairy buildings. The title of "Poultry Houses" is typical of the poultry structures projects. The swine structures projects are of about the same general order. The 5 miscellaneous projects also have quite general titles.

Covering corn stalks completely with an Oliver 18-in. moldboard plow. This has proven an effective method of corn borer control

The constantly increasing number of problems in farm structures would seem to warrant an increase in the amount of specific investigation which will gradually displace the more general work. The Secretary of Agriculture, in commenting on the work of the Advisory Council on Research in Mechanical Farm Equipment at its meeting in Washington on February 28, 1928, suggested that the same thing should be done for farm structures as the Advisory Council has been doing for farm machinery. He pointed especially to the importance, at this time, of specific fundamental investigations of the different features of the design of farm dwellings, for example, and it is known that his views along this line are also held by several of the leading experiment station directors. The present program includes only one project which is limited exclusively to this subject.

The Advisory Committee of the College Division of the American Society of Agricultural Engineers at its meeting in Washington on February 29, 1928, also drew attention to many pressing farm structures problems of a very specific nature which need fundamental treatment. It seems likely, therefore, that considerable room exists for the expansion of the research program in structures along more definite lines.

Irrigation. The program of investigation in the subject of irrigation, while consisting of only 30 projects, is fairly uniformly distributed among the stations in the 11 irrigated western states. The studies of water resources and irrigation methods and practices constitute the most extensive activities in the subject, and duty of water and water losses are also receiving some consideration.

An examination of these projects indicates a tendency to let the availability of water supplies be one of the important factors governing the nature and especially the extent of the reclamation of arid soils by irrigation. Following this practice closely is the determined effort to better utilize the limited water supplies by developing more efficient methods of meeting the moisture requirements of crops in different soils. This work is developing into truly fundamental studies of the functions of water in soils and of the reciprocal effects of water and soils in their bearing on efficient ways and means of artificially supplying crops with moisture and of conserving the limited supply to the utmost. The studies of water losses are obviously important supplements to this work.

Duty of water experiments, while undoubtedly important so far as they go, are gradually giving way to the more fundamental development of irrigation practices. This is another healthy sign which indicates that a housecleaning has been taking place in the irrigation investigations. The

manner in which the work has been intelligently pruned has, however, materially reduced the total amount of work in progress. A continued recognition of the work on the previous rather generous scale will require the organization of creditable new studies of the many pressing problems at hand.

Drainage. Twelve stations appear to have 26 active projects in drainage. This work seems fairly evenly divided between the drainage of humid and irrigated arid soils. The volume of work is also fairly uniformly distributed among the various stations concerned.

The character of the work in drainage does not seem to have changed materially for several years. The greater part of it appears to be more or less general in nature, the purpose apparently being to develop the principles relating only to the broad general aspects of drainage practices. Project titles such as "Drainage Studies," "Drainage Survey," and "Drainage of Wet Lands" predominate. The quantity of the work in progress seems to have decreased, however, indicating apparently that considerable of the general type of work has served its purpose and is being closed out.

There are one or two projects which indicate a tendency in some quarters to take up a study of the more fundamental aspects of soil drainage. Among these are, for example, the study of the influence of drainage on soil temperatures and that to determine the drainage requirements of tight clay soils and subsoils. It is being recognized by some that there is yet much to be learned about the hydromechanics of many soils before known hydraulic principles can be intelligently applied in their drainage.

Sanitation. The 16 projects in sanitation are active at 11 stations. Of these projects one appears to be general, 5 deal with water supply, 7 deal with sewage disposal and 3 deal with home ventilation and air humidification.

The total amount of work in this subject appears to have been reduced to a minimum. At one time considerable work was in progress. The tendency has been, however, to weed out the superficial and unproductive work with the result that much of what is left, while rather small in amount, seems to be pretty sound in principle. Such work in sewage disposal as that at the Illinois station, for example, is likely to persist and produce results. The opportunity to build up a program of sound investigation in this subject seems evident.

Electrification. The work in rural electrification is new. The 29 projects on record are at 17 stations only. Of these at least 16 projects appear to be very broad general investigations and surveys. It has been necessary in this new field to secure a general economic background and to gather and utilize available knowledge, so far as possible, before the extension of the use of electricity in farming practices beyond present knowledge could be intelligently undertaken. This probably explains in a measure why it has not been taken up more generally by the stations, especially in view of the fact that other state agencies in several instances have been developing this general background.

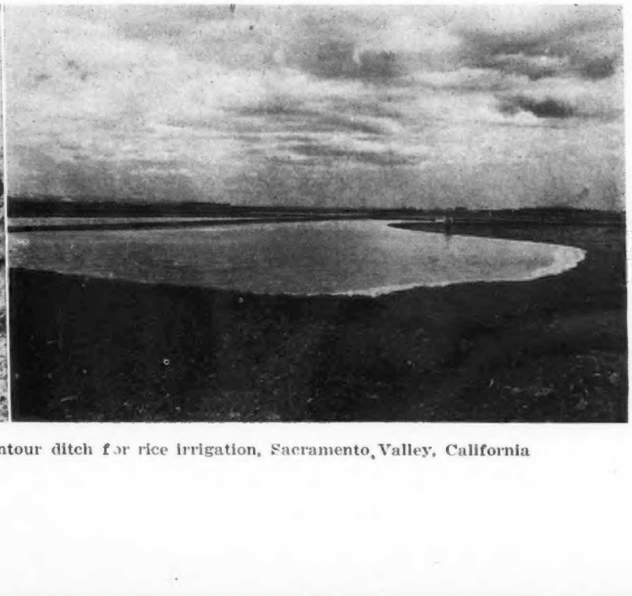
It appears, however, that the tendency now is in certain of those stations that have taken up the subject, to regard the general adaptation of what is already known as largely an extension activity and to devote the major effort by the station in the subject to specific studies of the problems involved in the further use of electrical energy in farming demanded by the economics of the situation. The programs of work at the Kansas, Oregon, and California stations, for example, indicate this tendency. The general preliminary work has indicated in many cases the lines along which further fundamental inquiry promises to be profitable. In this connection the remaining 13 projects on record which are at only 5 stations deal with certain features of windpower, motor belt work, and isolated electric plants. It seems likely, therefore, that the existence and future growth of this work in the stations will depend largely on its being narrowed down to the more specific fundamental inquiries.

Materials. The 22 investigations of materials of construction on record are at 12 stations. Of these projects, 9 deal with fencing materials, 3 with drain tile, 4 with roofing materials and 7 with miscellaneous materials such as concrete, rammed earth, and wall materials.

The work with fencing materials appears for the most part to be the comparative testing of the effect of known preservatives on wooden fencing materials which are available. This is presumably largely a conservation measure involving the more profitable utilization of fencing materials which would probably otherwise be of use for little else than firewood.

The work with roofing materials, while of much the same character, deals with a greater range of materials in order to determine what of those available will best meet the general roofing requirements of farm structures. Most of these, as well as the fencing material tests, are service tests of long duration. The work with drain tile, while very small in amount, is assuming a quite fundamental character. The studies of miscellaneous materials such as rammed earth are new and more or less general as yet, but the problems involved appear to be numerous. These offer promise of interesting and profitable developments.

The question of what character of materials to use in mechanical equipment and structures on farms is assuming considerable importance. The increasing use of high speed, automatic mechanical equipment which is subjected to constantly heavy stresses, to sudden and heavy overloads, and to considerable wear due to many friction parts is daily demanding a more profound knowledge of the materials of construction needed. The increasing necessity that equipment have a longer serviceable life and that the power requirements for its satisfactory operation be reduced to a minimum depend to a considerable extent upon knowing the best materials to use. The elucidation of the principles of moldboard friction by the Alabama station and the subsequent steps taken by that station, the California station, and by some of the commercial equipment companies toward the

(Left) Basin method of orchard irrigation. (Right) Contour ditch for rice irrigation, Sacramento Valley, California

development of means of control of such friction and the resulting wear and power loss by the proper manipulation of the materials going into the moldboard, constitute an outstanding example of the sort of work which should be done with materials of agricultural engineering.

The necessity for more permanent, better, and at the same time cheaper structures, is offering a tremendous problem to agricultural engineers. The importance of this was emphasized at the last annual meeting of the Advisory Committee of the College Division of the American Society of Agricultural Engineers when a conference was held with engineers and officials of the National Lumber Manufacturers' Association. Apparently what is not yet known about the proper manipulation of lumber as a material for farm structures will fill many volumes.

It seems likely, therefore, that while the work in materials of agricultural engineering is creditable so far as it goes, the attention given this subject is wholly inadequate. Agricultural engineering is no longer a new subject, but that phase of it relating to materials has hardly been scratched. Other organizations and branches of engineering cannot be depended upon to do this work since materials must be developed to meet certain conditions, often severe, which are for the most part peculiar to agriculture. A thorough recognition of this subject in research programs seems, therefore, of great importance if the purpose of agricultural engineering is to be attained.

Land Clearing. The program in land clearing at the experiment stations numbering 11 projects is in effect at 6 northern and western stations. This subject, while a difficult one from the research standpoint, appears to have been subjected to quite thorough investigation in some sections. The work has in the past been limited more or less to the development of brush, stump, and stone removal methods. It is interesting to note how the projects are now narrowing down to studies of the more specific problems involved. For example, one project which began in 1920 with a rather superficial consideration of at least seven rather broad and indefinite fields is now narrowed down to a specific study of the mechanical equipment required in only one of those fields.

This tendency undoubtedly accounts in a large measure for the rather small program of investigation in the subject now active at the stations. It seems also likely as areas are cleared and put into cultivation that it will gradually become a problem of decreasing importance. The amount of the work seems therefore to be governed largely by the economics of the situation.

Soil Erosion Prevention. The program of work in soil erosion prevention numbers 5 projects at as many stations, indicating a marked decrease in this important work. Several stations once quite active in this work do not now appear to have any projects in progress in the subject. This suggests that much of the work which was in progress has served its usefulness and been closed out.

The problem of soil erosion by wind or water and its prevention is one which has been of considerable concern to many national conservation agencies. It seems likely that the farm lands of no locality are entirely free from a certain amount of loss due to erosion. If the principles governing the tendency of soils to erode under certain external and internal forces are fully known, they have certainly not been made public. It is suspected, therefore, that erosion prevention measures are as yet to a large extent based on purely empirical findings and so-called practical experience. The development of a sound program of research in this subject as a cooperative undertaking in agricultural engineering and soil technology might, therefore, be a profitable develeopement.

Summary. It seems likely that the relatively small number of projects in some branches of agricultural engineering at the experiment stations as compared with previous programs may be attributed in a measure at least to the activities of experiment station administrative officials in reorganizing station programs. On the whole there is a striking indication that these officials are not so much in the dark as to what constitutes sound investigation in agricultural engineering as they perhaps were when the subject was entirely new. This has resulted in the elimination of much of the superficial or unproductive projects at some stations and the substitution therefor of stronger work where this was forthcoming. This procedure seems to have slashed into some agricultural engineering programs quite extensively. On the whole, however, it appears to have been a profitable move since it has undoubtedly increased the percentage of quality of some programs.

Graduate Training Facilities in Agricultural Engineering[1]

SOME time ago the Research Committee of the American Society of Agricultural Engineers undertook a survey of graduate training facilities in agricultural engineering in this country. A call has come from abroad to help foreign students in selecting the school for their graduate work. Within this country those now engaged in agricultural engineering activities often desire to advance their educational foundation and want to know where it may obtained. It has been felt that a survey of this kind would, if properly conducted, not only list the facilities available, but also acquaint the various schools of the demand and encourage them to offer inducements in the way of fellowships or scholarships to graduate students.

As agricultural engineering becomes more thoroughly established and more men are trained for agricultural engineering work, more stress will without doubt be placed upon advanced degrees. Some schools are already making demands of their staff members. Questions 5, 6 and 7 of the accompanying questionnaire were worded with this in mind.

In most cases it would seem that some encouragement is at present given to men ranking instructor or assistant professor. Some of these men may possibly complete their graduate study at their own respective institutions. Such, however, is not the case with those of higher rank. As suggested above, some schools are now requiring their men to secure advanced degrees. Some are offering further encouragement in the way of sabbatical leave on at least part time pay. Where an institution refuses to grant advanced degrees to its own staff members above a certain rank, it is of course necessary for them to seek graduate work elsewhere.

One possibility is in the exchange of instructorships. While there may be some difficulties in the way of decreased efficiency of departmental organization, it is believed that it offers some advantages in the sharing of ideas, the pushing out of the personal horizon, and the possibility of securing advanced degrees. This assumes that in the exchange a man will be permitted to pursue graduate study.

The survey shows a surprisingly large number in favor of such exchanges. It is of course understood that all exchanges would be individual cases and handled accordingly. It is also understood that answers to such questions were personal and in no way obligatory on the institution represented.

A copy of the questionnaire together with the results of the survey are presented herewith.

The Questionnaire

The Research Committee of the American Society of Agricultural Engineers is being constantly approached for information relative to facilities for advanced training for men engaged in agricultural engineering activites. For this reason the Committee has outlined for one of its activities a survey of existing facilities. Our object in this is two-fold:

First, that we may furnish an adequate list of facilities to men interested in taking advanced work, and

Second, that the Society may lend its influence toward acquainting the institutions with the desires of the various workers.

With this in mind, will you please give us the information requested in the following questionnaire?

Thanking you in advance for your consideration, I am

Sincerely yours,

Member, Research Committee, A.S.A.E.

[1]A report prepared by the Research Committee of the American Society of Agricultural Engineers.

Note: Numbering answer to correspond to the number of the question will suffice.

1. Do you offer graduate courses in agricultural engineering?
2. What are your requirements for admission to graduate study?
3. Do you offer fellowships or scholarships to encourage graduate work?
4. What are your residence requirements? Can one pursue graduate work in absentia?
5. Do you permit or encourage staff members to take graduate courses?
6. How much time are full-time staff members permitted to devote to graduate study?
7. What graduate degrees are offered?
8. Would you favor a policy of exchanging instructorships?
9. Would you favor a standardization of requirements for admission to graduate courses in agricultural engineering?
10. State desirable standards for admission.

State	Grad courses Ag. Eng.	requirements for admission	fellowships offered	residence requirements	staff permitted to take graduate	time allowed staff for grad. study	Ag. Eng. graduate degrees offered	do you favor a policy of exchanging instructors?	would you favor standardization of requirements for admission to grad. courses	desirable standards
Alabama	no	B.S. in Agr. + prerequisites	yes	limit 1/4 absentia	yes	1/4 time	M.S. in Ag.	no	yes - with flexibility	B.S. in A.E. or definite standards for candidates with B.S. in Ag. or Eng.
Arizona	yes	B.S. degree	no	20 units residence	yes	5 units	none	yes-with reservations	yes	
Arkansas	no		no		yes	3 hours per sem.		Could not do it	yes - as to math and phys	B.S. degree with definite standards in physics, theoretical mechanics, drawing.
California	yes	B.S. with qualifications	no	1 year	yes	4 hours per sem	M.S.	yes-with reservations	yes	
Colorado	no		no					yes	yes	
Connecticut	no		no						yes	
Delaware	no				yes	approx. 1/3 time		no	yes	
Florida	yes	B.S. in Agr.	yes	1 year-none in absentia	yes	1/4 time	M.S. in Ag.	yes	question possibility	
Georgia										
Idaho	yes		yes	Idaho grad. 1 sem others-1 yr.	yes	can get masters' in 2 years	M.S. in Ag.	no policy	to a limited degree only	B.S. in A.E.-except practical work in the field be accepted in lieu of college work
Illinois	yes		no		yes		none	yes	question possibility	B.S. in A.E. or equivalent at a grade A. institution
Indiana	no		no		yes	approx 1/3 time	M.S.	yes	not too close account local conditions	B.S. in A.E or B.S. in Ag. with adequate qualifications
Iowa	yes	B.S. in Ag. Eng. or equivalent	yes	1 year	yes	5 cr. hours		yes	yes	B.S. in A.E.
Kansas	yes		no	1 year	yes	5 cr. hours	M.S.	yes	yes if not too narrow	B.S. in A.E or equivalent
Kentucky	no									
Louisiana	no				yes					
Maine	no		no						yes	
Maryland										
Massachusetts	no									
Michigan		B.S. degree	no		yes	10 credits per year	M.S.	yes	yes in fundamental courses	B.S. in A.E-work in power and machinery: bldg const.; sanitation; land reclamation
Minnesota	yes		no		yes	about 1/5 time	M.S.	yes	difficult to standardize	B.S. degree with additional requirements according to specialization
Mississippi										
Missouri	yes	B.S. with qualifications	yes	none in absentia	yes	6 credit hours	M.S.	yes	yes	B.S. in A.E. or closely related subjects
Montana	no		no					yes	yes	B.S. in A.E. or B.S. in M.E or C.E. with 1 yr. ag or B.S. in Ag. with 2 yrs. engineering.
Nebraska	yes	B.S. in A.E. or equivalent	yes	1 year	yes	maximum 1/6 time	M.S. and professional	question advisability	yes-within limits	
Nevada										
New Hampshire										
New Jersey	no				yes	no definite allowance		yes	yes	
New Mexico	no		no		yes	outside time only		no	yes	
New York	yes	B.S degree	yes	1 yr. M.S. 3 yr. Ph.D.	no	(instructors) 1/2 time	M.S. Ph.D	yes	no	
North Carolina										
North Dakota	no									
Ohio	yes	B.S. with qualifications	no	3 quarters none in absentia	yes	5 hours per qr.	M.S.	yes	yes	B.S. in A.E.
Oklahoma	no									
Oregon	no		no		yes	3 cr. hours per term		yes	yes	B.S in A.E
Pennsylvania										
Rhode Island	no									
South Carolina	no							doubtful	yes	at least B.S. in Ag. with good foundation in physics, mechanics and math.
South Dakota	no							yes	yes	
Tennessee	no									
Texas	yes	A.B. with prerequisites	yes		yes	1/4 time	M.S.	yes		
Utah	yes	B.S. in engineering	yes	not definite	yes	no definite allowance	M.S.	yes	doubtful	
Vermont										
Virginia	yes	B.S. in Agr. or A.E.	yes	1 year	yes	no definite allowance	M.S.	yes	yes	B.S. in A.E.
Washington	no		no		yes	1 subject each sem.		not at present	yes	
West Virginia										
Wisconsin	yes	B.S. with qualifications	yes	1 year balance in absentia	yes	5 cr. hours	M.S.	yes	yes	B.S. degree with sufficient training in fundamental math or Ag. Eng.
Wyoming	no				no					

Results of a Study of the Strength of Wooden and Metal Breakpins

By A. H. Hoffman[1]

THE farmer has long regarded the wooden breakpin as an unsatisfactory safety release element in tractor-drawn implements. Wood is not sufficiently uniform in strength and too bulky for the average implement tool box to hold an adequate supply. Soft iron rivets are much more uniform, occupy little space, and are easily obtained. Their use does not cause serious deformation of the shearing edges in ordinary mild steel drawbars. If manufacturers would select slightly harder steels for the drawbar parts, there would be no appreciable deformation, even if ordinary steel wire nails were used instead of soft iron rivets. Miscellaneous bolts are unsafe to use as breakpins. They may be of special alloy steels that will not break when they should. Charts are given showing the results of tests of 252 pins of various kinds and sizes. Equivalent sizes in metal for given sizes of wooden pins are shown.

If it is only the middle of the morning and the tractor and plowing outfit are half a mile from the farmstead shop, when the last wooden breakpin lets go, the operator will be as "unusual" as bad weather in California, if he walks back for another wooden pin instead of using an old bolt or clevis pin out of the tool box. Yet the use of the bolt and the consequent absence of a safety release may easily cost a day's use of the outfit and possibly forty or fifty dollars for a new plowbeam. Some might feel inclined to blame the operator for his failure to have an adequate supply of wooden pins in the toolbox. He is usually not wholly to blame. How could he be expected to know that the two nicely painted pins that were in reserve in the toolbox when he went out that morning would not stand five minutes of ordinary plowing? Evidently a substitute is needed for the oak breakpin ordinarily used with quite a number of tractor gang plows. This paper gives the results of a study of the strength of wooden breakpins and of metal substitutes made at University Farm, Davis, Calif.

Sources of Wooden Pins Tested. To find out the strength and variations of the ordinary wooden pins, four dozen oak pins were obtained from two implement manufacturers and broken. These were apparently the ordinary run of the pins they supplied to their trade. Some of these, especially the 11/16-in. and ⅞-in. sizes, were noticeably widely variant in quality and the tests showed correspondingly large variation in strength.

The maple pins were made from dowel pin stock secured from two sources, the University Farm store room and the local lumber yard. In both cases the particular stock lengths selected for cutting up into pin lengths were chosen with the idea of securing the maximum variation in quality, some heartwood and some sapwood. Nevertheless there was less variation in strength than was shown by the oak pins.

The fir (Oregon pine) pins were homemade by cutting into 3½-in. lengths after ripping to ¾-in. square and then being driven through a die made by drilling a ¾-in. hole through a bar of ⅝x2½-in. iron. It should be stated that the thirteen fir pins tested were all made from the same 6-ft. length of lumber. This fact accounts in part for the small range in breaking strength observed for the fir.

Sources of Metal Pins. To find the maximum range of variation, the soft iron rivets were obtained from as many different sources as feasible. There were three lots of 5/16-in., five lots of ¼-in., and two lots of 3/16-in.

The wire nails were obtained from the storeroom supply and each of the three sizes divided into two lots, one of which was tested hard as received, while the other was wired into a bundle, heated to a good red temperature in a fire of wood and then left to cool off as the fire died out, the total annealing time being about four hours.

The ¼-in. bolts were two lots, one of machine bolts and one of carriage bolts, both lots obtained from the storeroom supply.

The ⅜-in. bolts were a mixed lot of junk bolts gathered up from various sources. They may be regarded as typical toolbox junk, their only points of likeness being that all were nominally iron and ⅜-in. in diameter. The lot contained ten machine bolts, five carriage bolts and one Ford connecting rod bearing bolt.

All the pins tested were long enough to be in double shear when undergoing test. Maple pins if too short tend to split when under stress and therefore to shear more easily. For this reason the maple and fir pins were cut 3½ in. long. The oak pins showed less tendency to split but were also of ample lengths.

Test Apparatus Used. Three sets of shearing bars were used in the test. One was the regular drawbar head and drawbar of a gang plow, Fig. 1. The pin hole in the cast head was ¾ in. in diameter; the punched pin hole in the ½x2-in. drawbar tapered from ¾ in. on the entering side to about 11/16 in. on the other side. This and the resulting compression of the wood probably accounts for the higher breaking strength of the ¾-in. maple pins when forced into this drawbar with a heavy hammer. The other two sets were of three bars each; one, the upper set in Fig. 2, had outer bars ⅜ in. by 2 in. and middle bars ½ in. by 1½ in. of ordinary mild steel, with Brinell numbers 138 and 134 to 144 for the side bars and 114 to 138 for the middle bar. The other set had bars ⅝ in. by 2¼ in. of mild steel, Brinell numbers 154, 154, and 154. Each bar had one end slotted for the clamp bolt holes. The clamp bolts held the bars closely but not tightly together. The bars as shown in Fig. 2 are not spaced. For some of the tests spacing washers were used to simulate the clearance often found between cast

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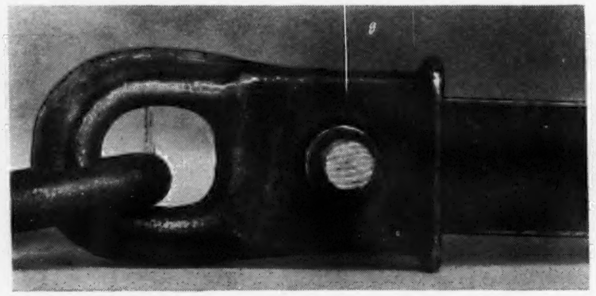


Fig. 1. A regular cast drawbar head was used for some of the tests

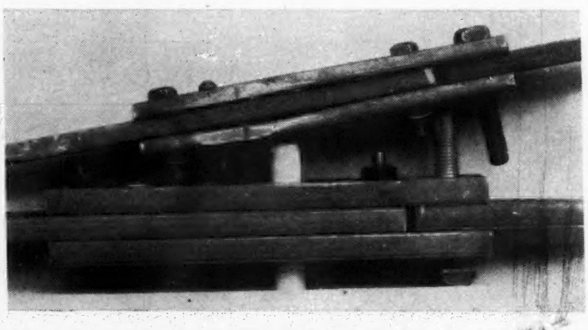


Fig. 2. Two sets of three bars each having holes for pins of different diameters were used. The last test made in the upper set of bars was on a ⅜-in. machine bolt in the ¾-in. hole. The ⅜-in. bars bent badly and the load went above 15,000 lb.

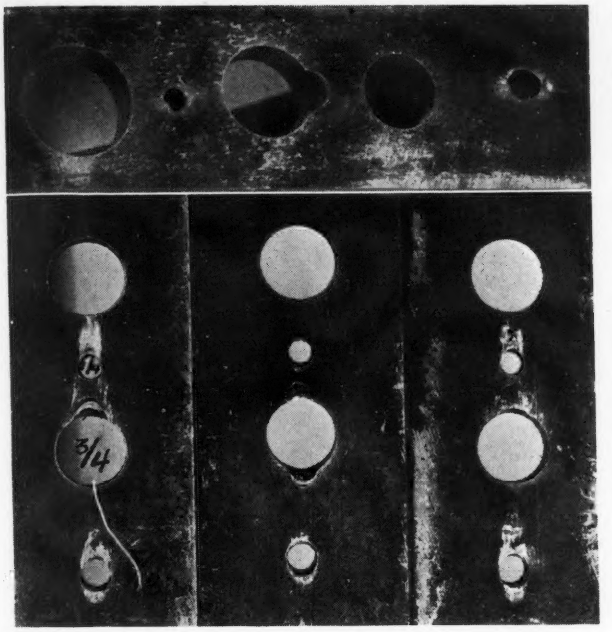


Fig. 3. (Top) The lower bar of the upper set of Fig. 2. The smallest hole had eleven 3/16-in. iron rivets broken in it, the next (¼-in.) had 42 iron rivets and 10 bolts. The badly marred hole is the ¾-in. The other holes had wood pins only

Fig. 4. (Bottom) The ⅝-in. set of bars after the tests. The smallest hole (¼-in.) after twelve 20d nails broken; the next size (5/16-in.) after twelve 40d and twelve 60d; the ¾-in. after breaking fourteen ordinary ⅜-in. iron bolts and one Ford connecting rod bolt, which was broken last

heads and drawbars. One set of washers spaced the bars 0.041 in. and the other 0.077 in. on each side.

The forty-two ¼-in. soft iron rivets broken in one hole in the thinner set of bars caused only slight deformation of the shearing edges. In the same set of bars a ⅜-in. machine bolt badly bent one of the ⅜-in. bars and so blunted the shearing edges of the ¾-in. hole in which it was placed (Fig. 3), that the load went above 15,000 lb. before the bolt failed. It is possible that no bending would have resulted if the ⅜-in. bolt had been in a hole of its own proper size. In the slightly harder ⅝-in. bars, the wire nails, both the annealed and the soft, and fourteen of the ⅜-in. bolts were broken without very much deformation of the shearing edges. However, the alloy steel connecting rod bolt caused a very decided deformation in the ⅝-in. bars not only of the edges of the ¾-in. hole but for about half the thickness of the outer bars and almost entirely through the middle bar.

Two testing machines were used to break the pins. One was a Riehle 30,000-lb. tension-compression-crossbending machine at the civil engineering testing laboratory of the University of California at Berkeley; the other was a Riehle 200,000-lb. tension-compression machine in the testing laboratory of the California Highway Commission at Sacramento.

Load-deformation diagrams were taken for about half the specimens by use of a simple semi-automatic graphic recording device[2], Fig. 5. Fig. 6 shows a typical diagram for 1-in. oak pins. As will be noted, the curve follows closely that for elastic bodies for only a short distance from the origin; then the specimen yields rather rapidly for a time; it gradually recovers and then supports the increasing load with practically proportional deformation to the point of failure. The net deformation just before failure at 9,480 pounds was .40 inch. The metal pins showed typical stress-strain curves for steel in shear, as would be expected.

Results. The results of the tests made are shown for wood in fig. 7, for metal in fig. 8, and for all, maxima, minima, and averages, in fig. 9.

It will be noted that the wooden pins were much less uniform in breaking strength than the metal pins and that they were weakened more markedly by the spacing of the bars than were the metal. The pins of smaller diameter were more affected by spacing than were those of larger diameter; also spacing seemed to affect the ¾-in. oak pins more than the maple pins of the same size.

A 12-lb. hammer was used to drive ¾-in. maple pins into the tapering punched hole in the bar in the regular drawbar head used in some of the tests. That this compression of the ¾-in. maple pins to 11/16 in. diameter markedly increased their breaking strength is clearly shown (Fig. 7). These pins were a very tight drive fit. It was found impossible to get them in without battering to pieces when a 1¼-lb. hammer was used.

Equivalent Pins of Wood and Metal. The figures (Figs. 7, 8 and 9) show that 5/16-in. soft iron rivets may be substituted for 1-in. oak pins and because of their greater uniformity furnish considerably better safety insurance than the oak. Likewise ¼-in. rivets may be safely substituted for ¾-in. oak pins with much more satisfactory results. Wire nails, size 40d, either annealed or unannealed will also prove usable, though they will burr the shearing edges of the holes in the ordinary mild steel drawbars somewhat more than soft iron rivets. For the 11/16-in. oak pins size 20d wire nails unannealed are an almost exact equivalent though much more uniform. Size 30d wire nails if thoroughly annealed would probably also be equivalent and less liable to cause much marring of the shearing edges. The ¼-in. common iron machine and carriage bolts tested were also equivalent to ¾-in. oak pins. However, it is not safe to pick up any old quarter-inch bolt and use it assuming that it is common iron. It may be chrome-vanadium steel or some other alloy that will bear possibly twice the load that will break ordinary iron of the same size. The safest way is to buy half a pound of soft

[2]It consists of a card in a holder attached to the middle bar of a set. Putting the card into place at zero load traces the line zero deformation. After each 500-lb. increment of load the card it pulled out one-half a space. If the load exceeds 10,000 lb. the card may be pushed back until the pencil again rests on the starting line. Other scales than 1,000 lb. per space may be used.

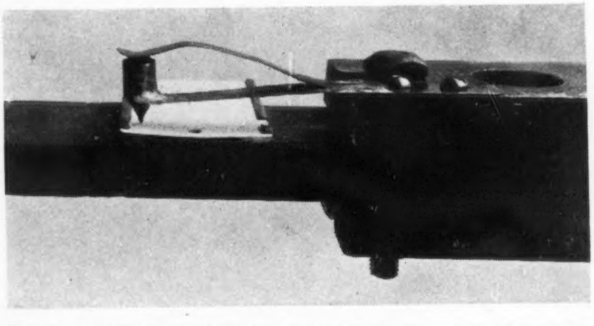


Fig. 5. A simple recorder for load-deformation. The deformation is recorded automatically; the load is recorded by drawing out the card by hand a half-space for each desired increment of load. This may be readily adapted to other stress-strain studies

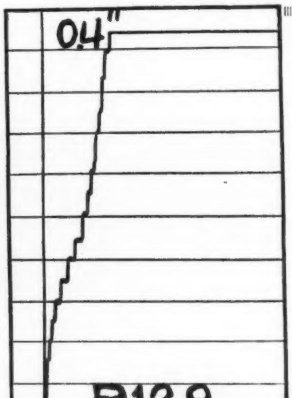


Fig. 6. A typical load-deformation curve for good oak break-pins 1 in. in diameter. The fibers were crowded together at from about 3,000 to about 6,000 lb. load. Then the pin "got its second wind" and supported the increasing load with about proportional deformation to failure at 9,480 lb.

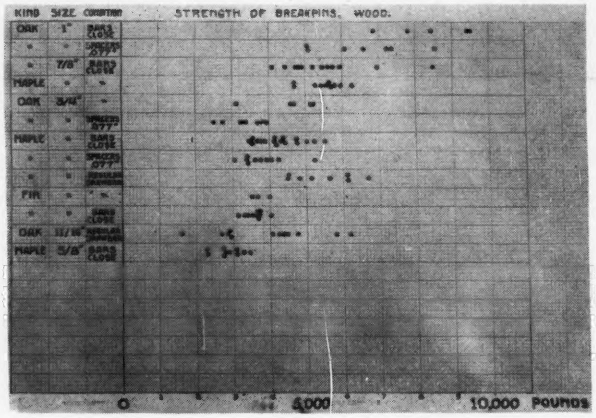
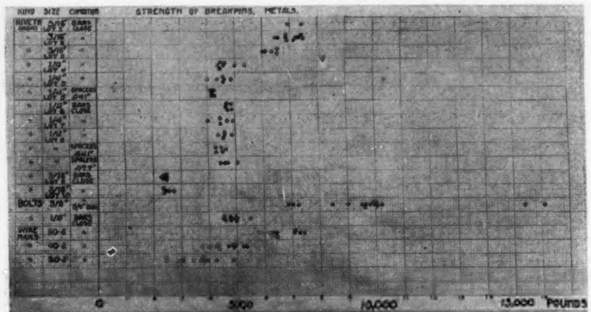


Fig. 7. Each dot shows the results of a single test. The smaller sizes of oak pins varied most and were most affected by spacing of the bars. The homemade fir pins were all cut from one piece of lumber

iron rivets and put them in the toolbox. It will be noted that the 3/16-in. rivets tested showed very close uniformity and were about equivalent to ⅝-in. maple pins. They were broken in 3/16-in. holes. It was found rather bothersome to remove the pieces from the small holes. If the 3/16-in. size rivet is needed, it would be well to drill the holes for it to ¼ in. diameter. The rivet (or 16d wire nail annealed) should be obtained long enough to extend through the bars. Bending the end over to one side will prevent losing out.

Adapting Machines for Metal Breakpins. In most drawbar heads made for wooden breakpins there is ample room to drill another hole for the equivalent size of metal pin. It is better to drill the new hole rather than to use metal in the hole designed for wood, since in holes of appropriate size the metal pins are more certain to break at the right overload. In the larger holes they might tend to bend light bars and not release in time to protect the machinery.



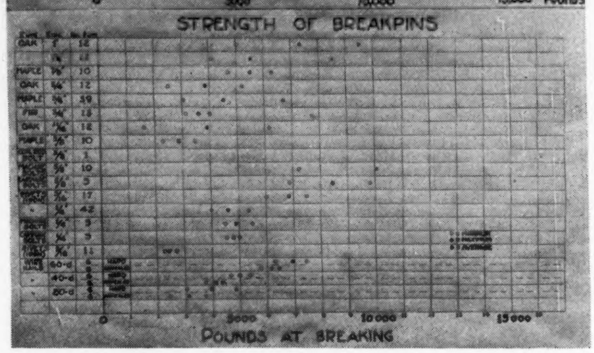


Fig. 8. (Top) The metal pins were in general more uniform in strength than the wooden pins. Two exceptions were found in testing ⅝-in. junk bolts. One alloy steel connecting rod bolt went up to nearly twice the average. The other exception was caused by one set of shearing bars bending because too light

Fig. 9. (Bottom) Averages, maxima, and minima for all the lots of pins tested. Equivalent strengths may be obtained by comparing averages

EDITOR'S NOTE: A paper on other parts of the foregoing study—having to do with the use of springs—is in preparation by E. G. McKibben, agricultural engineer, University of California, and will be published in an early issue of AGRICULTURAL ENGINEERING.

Right Painting of Wood

PAINT blister can be prevented by care in seeing that wood is dry before putting on the first paint coat and by care in constructing houses to see that moisture does not seep through from the interior to the exposed face of the exterior siding. Blistering and peeling of paint, results when the wood in contact with the paint coating becomes wet. Ordinarily it is impossible to get the lumber wet after a good coating of paint has been applied, but where an outer surface only is covered, as in the siding of houses, moisture caused by contrast of room and wall temperatures may percolate through the boards from the inside and cause bubbles or blisters to arise on the coated surface.

Wood in the air-dry condition, roughly containing from 10 to 15 per cent of moisture, is below the danger line and within the fiber saturation point.

The variations in the moisture content of commercially dried lumber as it is delivered to the job are hardly likely to be great enough to lay any of it open to danger of paint peeling, unless there has been some very gross departure from accepted standards of good practice in handling it. When blistering and peeling has been observed, the large amounts of moisture required to cause it have almost always appeared to have gained access to the wood after its delivery to the job.

Wood that has been allowed to take up moisture after delivery to the job may or may not have soaked up enough to cause early blistering of the wood, but it may weaken the adhesion of the entire coat of paint and become apparent later in cracks or peel in long shreds. Delay in painting where the wood has become wet until the weather has had an opportunity to thoroughly dry it is advisable.

Winter building is not conducive, under ordinary circumstances, to a good paint job result. Special note is made of the likelihood of such construction being occupied and heated before the walls have had a chance to dry. Then the drying process becomes an artificial one in which warm interior heat forces the moisture of plaster walls out through the house siding, a direct method of producing blistering under the exterior painted surface. Drying of new houses by opening doors and windows is advocated because this method permits circulation of air of nearly the same temperature as that of the outdoor atmosphere, and not only is the dampness carried off on the inside air currents, but no new moisture is caused from wall and room-interior temperature contrasts. Single coat painting on winter built construction is also encouraged where it is possible to let the completing of the painting job go until the warm weather has had a chance to thoroughly dry the outside lumber or siding.

In many cases where there has been no peeling and only small blisters have developed, it may be possible to repaint without removing the orginal coating. Before doing so, care should be taken to see that the walls are thoroughly dry, so that there will be little likelihood of a recurrence of the difficulty.

Standard Symbols Approved

APPROVAL of mathematical symbols as American Standards has just completed the first step in a program of unification of the scientific and engineering symbols and abbreviations used in engineering and industry, under the auspices of the American Engineering Standards Committee. The confusion resulting from variations in symbols used in different publications, reports and tables, led to the initiation of a project of unification by the Committee early in 1923. The work has been progressing since that time, with 14 national organizations participating.

Rate of Infiltration of Water into Soils[1]

By M. R. Lewis[2] and E. H. Neal[3]

IN EACH of the arid states the ultimate agricultural development will depend on the area to which a limited water supply may be extended. Perhaps the most important phase of this general problem of the duty of water is that of proper application to the land. It is a fact that, next to the amount of water available, the greatest factor in the actual duty on the farm is the character of the soil. On coarse soils the duty is almost universally lower than it is on finer soils. The difference is due in the main to the excessive rates of infiltration of water into the coarser soils.

Realization of this fact has led the Idaho agricultural experiment station to undertake a study of the factors underlying the rate of infiltration. A study of the published literature discloses a very small amount of data. The most extensive work seems to have been done by Messrs. Muntz, Faure and Laine in France. Their results and the scattered reports of others indicate that some standardized laboratory test is necessary in order that the results of different workers, and those obtained on different soils, may be compared. In the field the variable factors are so numerous that it is impossible to secure consistent results even when tests are made within a few feet of each other.

As the whole project will require an indefinite period for completion it seems best to report the various tests as they are conducted even if the data is very fragmentary.

[1]Approved for publication by the director of the Idaho Agricultural Experiment Station as Research Paper No. 56.

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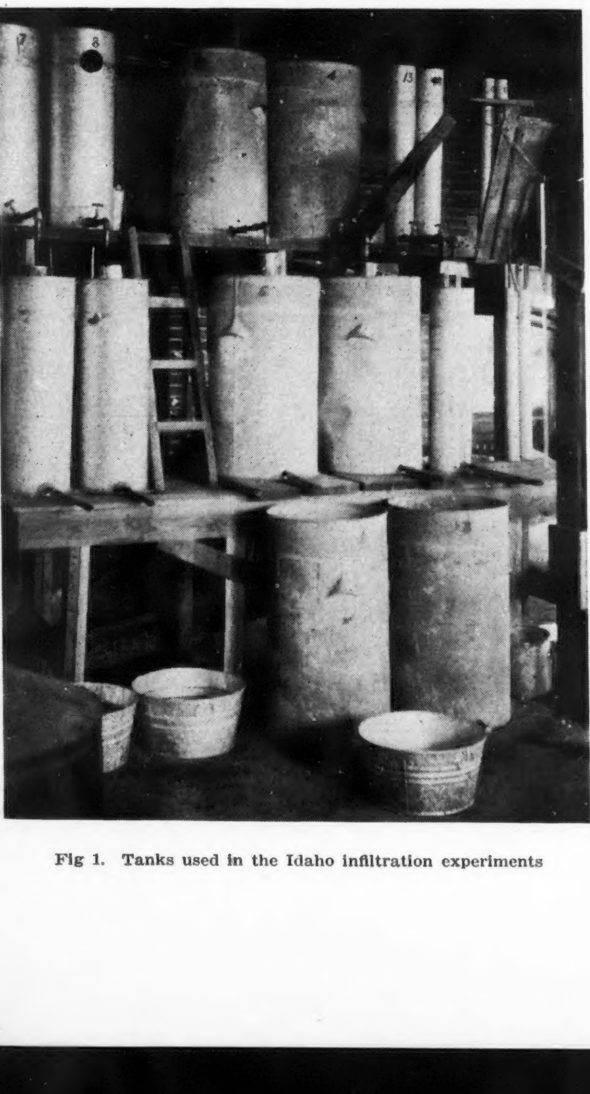

Fig 1. Tanks used in the Idaho infiltration experiments

Equipment and Soil. The equipment used consisted of a series of galvanized iron tanks 36 in. deep and 3, 6, 12 and 20 in. in diameter, and equipped with an outlet pipe at the bottom; a number of hook gages, with the staff graduated to read directly to 0.01 ft. and by estimation to 0.001 ft.; and a set of gages for obtaining the soil surface elevation. The set-up is shown in Fig. 1.

In this work Palouse silt loam, the most common of the local soils, has been used. The mechanical analysis of this soil, according to U.S.D.A. Bureau of Soils standards, as determined from samples taken at the time of mixing the soil, is as follows:

Mechanical Analysis of Palouse Silt Loam

Separate	Per cent by weight	Remarks	
Fine gravel	0.4	Total sands	20.7 per cent
Coarse sand	0.4	Loss on ignition	6.4 per cent
Medium sand	0.3	Moisture equivalent	25.5 per cent
Fine sand	5.2	Volume weight in	
Very fine sand	14.4	the field 62.5 lb.	
Silt	69.3	per cu. ft.	
Clay	10.1		

Two unusual characteristics of this soil will be noticed. The fact that 83.7 per cent of the soil particles are included in the adjacent separates of very fine sand and silt is probably connected with its Aeolian origin. The apparent specific gravity in the field is almost exactly unity.

In obtaining the soil care was taken to secure only surface soil. This was hauled to the laboratory, spread over the floor and mixed, then screened through a ¼-in. mesh screen and thoroughly mixed by shoveling over twice. It was then quartered (each fourth shovelful in a separate pile) until a small quantity remained as a representative sample for the physical determinations. Investigations, made before filling the tanks with soil, showed that if the volume-weight of the soil when originally placed in the containers was to agree with the volume-weight as found in the field, tamping of the soil was unnecessary. Rather, methods should be employed which would prevent packing.

The water supply cans were equipped with a pipe with its outlet over the center of the soil container. Regulation of the discharge of water from the supply can was secured by means of a valve inserted in the outlet pipe. As the tank which held the water supply was in each case of the same diameter as the soil container the depth of water applied in any period was equal to the drop in the water level in the supply can plus or minus the change in depth of water on the surface of the soil. The percolation from the soil cans was caught in tubs and buckets and weighed periodically.

First Set of Trials. The set of cans as described above was filled with soil and irrigated a number of times. As the irrigations proceeded it was found that the rate of absorption decreased rapidly with each trial but not uniformly as between different sizes of cans. No uniformity in the rate of infiltration was secured even after repeated irrigations. The results do not seem to be worth reporting in detail.

Since the soil cracked away from the can around the top it seemed probable that the excessive infiltration secured in the smaller cans was due to seepage along the inside wall of the can. In an attempt to determine whether this was true or not the following mathematical analysis was carried out:

Let R_c equal the rate of seepage along the walls of the can in cubic feet per hour per foot of circumference.

Let R_s equal the rate of infiltration into the soil of the can in cubic feet per hour per square foot of surface (or feet depth per hour).

Let M_3, M_6, M_{12} and M_{20} equal the total depth of water infiltrated in feet per hour for the 3, 6, 12 and 20-in. cans, respectively.

$$\begin{aligned} \text{Then } 0.78\,R_c + 0.048\,R_a &= 0.048\,M_3 \\ 1.57\,R_c + 0.195\,R_a &= 0.195\,M_6 \\ 3.14\,R_c + 0.781\,R_a &= 0.781\,M_{12} \\ 5.25\,R_c + 2.20\ \ R_a &= 2.20\ \ M_{20} \end{aligned}$$

Substituting the experimental values for M_3, M_6, etc. and solving these equations simultaneously for R_c and R_a gave a variety of values for these factors. In many cases negative values for R_a were secured. Only by making the self-evident erroneous assumption that the width of the crack along the wall of the soil can was inversely proportional to the diameter of the can could positive values for R_a be secured. It thus became evident that some other factor than the seepage along the wall of the cans was present.

Relation of Size of Can to Settlement. The same cans were filled with fresh soil and irrigated in July and again in August. The soil was removed from all the cans and they were filled for the third time and irrigated in September. These three irrigations on two lots of soil will be considered together. The first of these runs was made continuously for a period of 24 hr., then for a period of an hour or so there was no water on the surface of the soil and after that the run was continued for twelve hours. The second and third runs were made continuously for forty-eight hours. The soil was part of the same lot used for the first filling. Care was exercised in placing the soil in the cans in an attempt to secure a uniform volume-weight. (See Table I for the volume-weight of the soil before irrigation.)

As soon as irrigation of the soil in the cans commenced the soil began to settle. This settlement was measured carefully by means of gages set on the surface. The rate of settlement was comparatively rapid for the first two or three hours, gradually decreasing until practical equilibrium was reached at the end of twenty-four hours.

The soil in the various cans did not settle at a uniform rate or to a uniform density. Table I shows the volume-weight of the soil in each can twenty-four hours after irrigation started. It is evident that the size of can has a very definite effect on the settlement of the soil. This irregular rate of settlement seems to explain many of the discrepancies found in the earlier runs. In view of the fact that in the 3-in. cans the soil of the second filling settled from a mean weight per cubic foot of 57.6 to 58.9 lb., while in the third filling in the same length of time the increase was from 55.5 to 64.1 lb., it would seem to be difficult to foretell what the final volume-weight will be in any individual case. In the larger cans the final volume-weight is much more uniform. In the 20-in. cans the extremes at twenty-four hours after the first irrigation commenced were 68.4 and 71.1 lb. per cu. ft. The final weights (after two long irrigations of the second filling and one of the third) showed extremes of 69.9 and 71.1 lb. per cu. ft.

TABLE I. Volume-Weights of Soil in Containers

		Second Filling				Third Filling	
		First Irrigation		Second Irrigation		First Irrigation	
Diam.—in.	No.	Before Irrigation Commenced	After 24 hr. Irrigation	Before irrigation commenced	After 24 hr. irrigation	Before irrigation commenced	After 24 hr. irrigation
3	16	56.7	57.6	58.0	58.6	56.0	64.7
3	15	58.6	60.2	60.3	60.3	55.0	63.5
6	12	55.3	63.2	63.5	64.2	59.4	66.3
6	11	55.5	62.0	62.5	63.5	59.1	65.8
12	10	58.8	61.7	62.8	63.5	60.2	67.8
12	9	57.9	64.0	64.4	64.7	59.5	69.0
20	6	56.3	68.5	69.9	69.9	62.4	71.1
20	5	56.1	68.4	70.4	70.4	62.5	71.1

Infiltration and Porosity. The porosity or pore space of a soil may be determined from the formula:

$$P = \frac{S - A}{S} \times 100$$

P = the porosity in per cent

S = the specific gravity of the soil material

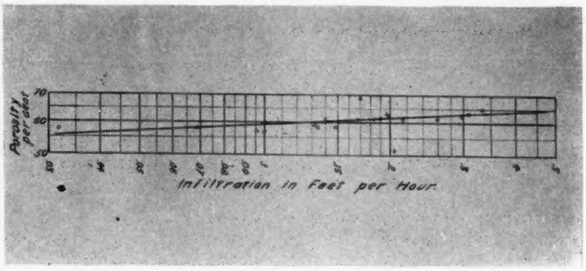

Fig. 2. Graph showing rate of infiltration into Palouse silt loam of varying porosity after 24 hr. continuous irrigation

A = the apparent specific gravity of the soil in a body

The specific gravity of soil minerals is generally assumed to be 2:65 or, as more commonly expressed, 165 lb. per cu. ft. With this assumption the porosities corresponding to various volume-weights are shown in Table II.

TABLE II. Pore Space in Per Cent Corresponding to Various Volume-Weights

Volume-Weight —lbs. per cu. ft	Pore Space Per cent
55	66.7
57	65.5
59	64.3
61	63.1
63	61.8
65	60.6
67	59.4
69	58.2
71	57.0

It is known that the rate of infiltration of water into soil will vary with the porosity. The data secured in this experiment, and shown in Table III, offer an opportunity to correlate the rate of infiltration with the porosity. Plotting infiltration against volume-weight gave a curve which appeared to be parabolic. To test this the rate of infiltration was plotted against porosity on logarithmic scales as shown in Fig. 2. A straight line may be drawn which closely fits the plotted points. The straight line shown gives the following formula for the rate of infiltration:

$I = 1150\ P^{18}$

I = rate of infiltration in feet per hour after twenty-four hours irrigation

P = porosity expressed as the fraction of the total volume of the soil which is occupied by air or water spaces.

TABLE III. Porosity, Volume-Weight and Rate of Infiltration Twenty-four Hours After Each Irrigation Started

	Second Filling						Third Filling		
	First Irrigation			Second Irrigation			First Irrigation		
Container No.	Vol.-Wt.—lb. per cu. ft.	Poros.—per cent	Infil.—ft. per hr.	Vol.-Wt.—lb. per cu. ft.	Poros.—per cent	Infil.—ft. per hr.	Vol.-Wt.—lb. per cu. ft.	Poros.—per cent	Infil.—ft. per hr.
16	57.6	65.1	0.333	58.6	64.5	0.449	64.7	60.7	0.156
15	60.2	63.4	0.310	60.3	63.4	0.196	63.5	61.5	0.140
12	63.2	61.6	0.260	64.2	61.0	0.168	66.3	59.8	0.100
11	62.0	62.4	0.298	63.5	61.5	0.184	65.8	60.1	0.108
10	61.7	62.6	0.198	63.5	61.5	0.189	67.8	59.3	0.132
9	64.0	61.2	0.214	64.7	60.7	0.162	69.0	58.2	0.069
6	68.5	58.5	0.134	69.9	57.6	0.032	71.1	56.9	0.096
5	68.4	58.1	0.148	70.4	57.3	0.050	71.1	56.9	0.100

This formula will, of course, apply only to the one soil under the conditions of this experiment. No indication could be found that the size of the container had any effect on the rate of percolation except as it affected the amount of settlement and therefore the porosity. The effect of porosity on the rate of infiltration is evidently very great. Perhaps this is the factor which varies between various trials in the laboratory and field and between the two classes of trials. Quite possibly this factor accounts for the difficulty in getting comparable results.

Ice Cooling Applied to Apple Storage*

By C. I. Gunness[1]

THE McIntosh has come to be recognized as one of the most important varieties of apples grown in Massachusetts. A great many of the younger orchards contain a high percentage of this variety. McIntosh apples are generally picked during the last two weeks in September. At that season common storage offers a relatively high temperature for apples, and growers have for a number of years been interested in getting better storage facilities for these early apples. Mechanically refrigerated storages do, of course, offer the ideal solution of the problem, but in many cases commercial storages are not available and the grower cannot economically build and operate such a storage for the relatively short season during which artificial cooling is required.

In order to improve on common storages, two methods suggest themselves. One is to utilize to the fullest extent the cool night air for cooling purposes. The other is to use ice for cooling during the few weeks in the fall when artificial cooling is necessary. Very little is to be gained from night air in the average season in our latitude during the month of September. As an average for the last six years we find that at Amherst the temperature fell below 40 deg. for only 5 hr. during the third week in September and 10 hr. during the fourth week in September. In like manner the number of hours in each week on which the temperatures fell below 40 deg. during October were respectively: First week, 10.7 hr.; second week, 24.5 hr.; third week, 47 hr., and fourth week, 55 hr. The above figures are averages. In any one season there may be even less opportunity for cooling with air than these figures would indicate. During the first week in October in 1927, the temperature did not fall below 40 deg. As has been pointed out by Marble and others, the ground temperature is the greatest factor in determining the temperature in a common storage. Even with a very rapid air change on a cool night, the heat removed by the air will frequently no more than make up for the heat entering through the floor and walls. Even with a considerable drop in temperature obtained during the night in the storage, the temperature usually climbs again in the morning and by noon or a little later the room is where it was before the ventilators were opened.

*Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Pittsburgh, Pa., October, 1927.

[1]Professor of agricultural engineering, Massachusetts Agricultural College. Charter Mem. A.S.A.E.

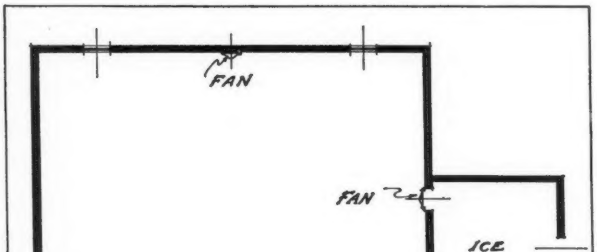

Fig. 1. Floor plan of ice cooled apple storage

Assuming a specific set of conditions may help to show the futility of air cooling. We will consider a storage 36 by 54 ft. with a 9-ft. ceiling, giving a cubical capacity of 17,500 cu. ft. We will assume that the air is changed once in 10 min. or at the rate of 1750 cu. ft. per minute. Assume the ground temperature at 55 deg. F. and the temperature in the storage also at 55 deg. We will assume that the outside air temperature falls to 40 deg. and is available for 8 hr. Also assume that the air leaves the storage at 50 deg. Under these conditions the air would remove 168,000 B.t.u. during the 8-hr. period. With concrete walls the heat leakage would be 99,000 B.t.u. during the same period leaving 69,000 B.t.u. for cooling the apples. If the storage holds 4000 bu., these apples would be cooled only 2.6 deg. This would be the maximum cooling which could be expected. In actual practice the circulation would very likely not be sufficient to cool all the apples uniformly even to this extent. As soon as the ventilators are closed the temperature will again rise very rapidly to ground temperature.

The purpose of this paper is to report on a storage which was cooled with ice during the 1926 season. This storage is a room 36 by 54 ft. with 9-ft. ceiling. Walls are insulated with two thicknesses of Celotex with a 2-in. air space. The floor is insulated with 4-in. of cork. The ceiling is a double floor on top of joists with Celotex on ceiling. The storage is, as indicated, well insulated, although not as thoroughly insulated as would be necessary to make mechanical refrigeration practical. An ice bunker 8 by 10 ft. was built outside of the storage proper as shown in the accompanying floor plan, Fig. 1. This bunker is filled through a cellar window at a minimum expenditure of labor. A 24-in. propeller fan is placed near the floor to draw cold air from the ice bunker and discharge it into the storage. The warmed air returns to the ice bunker near the ceiling.

The design of this system of cooling has the following points of merit:

1. The bunker is filled at minimum cost, in that large cakes of ice are used and the bunker has a large capacity.
2. The fan system makes it possible to obtain rapid melting of the ice with a corresponding increase in cooling. One of the difficulties in using ice for cooling lies in getting rapid melting. A film of cool air around the ice insulates the ice and prevents melting. A fan brings new warm air in contact with the ice at all times and helps to produce maximum refrigeration.
3. The fan serves to distribute cool air throughout the storage and helps to maintain high humidity. Air being drawn over melting ice will obviously absorb a good deal of moisture which is desirable in producing favorable storage conditions.

A 24-in. propeller fan is used to discharge air from the storage to the outside through one of the cellar windows. Five intakes are provided for the admission of the cold air. The purpose of this ventilation system is to cool the storage whenever the outside temperature is lower than the temperature in the storage. At all other times the ventilators are kept closed. The fan was put in to take the place of four large outtake flues running through the roof. The reasons for making this change were to insure positive circulation independent of wind velocity and to save space in the room above the storage. The fan has a capacity of 3,000 cu. ft. per minute.

During the season of 1926 an average of 4 tons of ice was maintained in the ice bunker throughout a six-week period beginning September 17, and a total of 43 tons of ice was used in 45 days. Ice melted at an average rate of 2125 lb. per day.

The ice cost $4.50 at the ice house, or about $6 at the storage. The total cost of ice was $260 in the ice bunker. Power to operate the fan cost 35 cents per day, or $16 for the 45 days. The cost of insulating the storage came to $1200. Interest on this at 6 per cent amounts to $72. The total cost of cooling is then $348. On the basis of 7,000 bu. as the capacity of the storage, the cost of cooling becomes 5 cents per bushel.

The result as far as cooling is concerned is shown on the accompanying chart, Fig. 2. The temperature of a common storage is shown for comparison with the one in which ice was used. The storages, however, were about 25 mi. apart, the common storage being in a cooler location as shown by thermograph records of outside temperatures kept at both locations. An uninsulated room adjacent to the refrigerated storage served as a better check as to the fall in temperature brought about through the use of ice. This uninsulated room was invariably about 10 deg. warmer than the refrigerated room. Records of a number of common storages show that a temperature of 60 deg. can be expected in such storages on October first. As shown by the chart, the temperature in the insulated, refrigerated room was 50 deg. on October first.

Whether the use of ice in this manner is worth while is, of course, a debatable question. There is a vast difference in placing apples in storage at 50 deg. and placing them in a commercial storage at 32 deg. On the other hand, there is some advantage in placing at 50 deg. over placing in a storage at 60 deg. It is, obviously, up to the pomology men to determine what temperatures are required for the proper holding of different varieties of apples. Considerable data are available on this point, but apparently data obtained in one locality are not always applicable in another locality. Then, too, the keeping quality of apples varies a great deal from year to year.

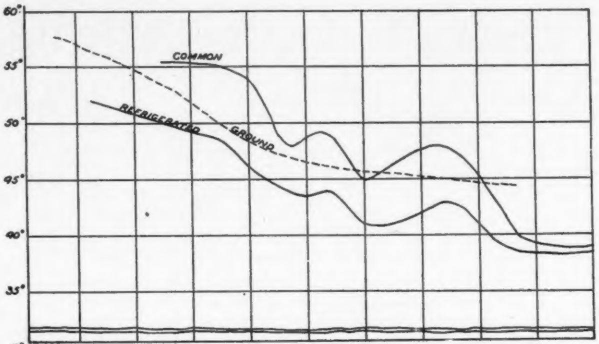

Fig. 2. Temperature curves of common and refrigerated storages

In order to get some idea as to the efficiency of various storages a test was conducted during the 1926 season. Twelve bushels of McIntosh apples were picked from one tree on a given day and placed in four different storages—3 bu. in each storage. One of these storages was the common storage shown on the chart; another was the refrigerated storage also shown on the chart; a third was another iced storage, and the fourth was a commercial cold storage plant in Boston. The apples were inspected by a pomologist at the time of picking and at various times throughout the season, the final inspection being made on March 10. This test indicated very clearly the inferiority of the common storage and showed practically no difference between the apples which were kept in the ice-cooled storage and those kept in the refrigerated storage at 32 deg. This being only for a single season should not be construed as evidence that ice cooling is sufficient for all cases, but it does show that cooling the apples to 50 deg. has a decided advantage over holding them for a considerable period at 60 deg., until the cool fall weather finally brings a common storage to a lower temperature.

Drainage of Irrigated Land for Alkali Control

THE importance of drainage as a means of preventing the accumulation of salts in irrigated lands is clearly outlined by C. S. Scofield, in charge of western irrigation activities for the Bureau of Plant Industry, U. S. Department of Agriculture, as follows:

"An adequate drainage system is as essential to a tract of irrigated land as a sewage system is essential to the well-being of a city. . . . . . . The field is level, or approximately so. The soil, to the depth of 5 or 6 ft. constitutes the root zone. In this root zone is suspended the soil solution. The work suspended is used advisedly, because the soil solution is held in the root zone against the force of gravity. The roots of crop plants are distributed throughout the root zone in contact with the soil solution. In process of growth the plants absorb water through their roots from the soil solution. A very small part of this water is used in making plant tissue; by far the larger part is evaporated from the leaves by the process of transpiration. Under normal field conditions our ordinary crop plants transpire about 500 lb. of water for each pound of plant tissue that is formed. This water is all absorbed through the roots from the soil solution. It should be clearly understood that the plant roots absorb water from the soil solution; they do not absorb the whole of that solution. Some of the dissolved elements are taken up to be utilized by the plants in the process of growth, but the quantity so absorbed is relatively very small when compared with the total quantity contained in the solution . . . .

"In the Mesilla Valley near Las Cruces the water from the Rio Grande used for irrigation contains about 900 lb. of salts in each acre-foot of water. The annual irrigation amounts to about 2½ ft., adding something more than a ton of salts to the soil of each acre each year.

"The direct effect on the plants is that the solution of salts, eventually may become so concentrated that the process of absorption through the roots is interfered with. Studies of plant growth have not indicated that the ordinary crop plants are more sensitive to one combination of the ordinary salts than to another, but they must be able to take up water enough for transpiration and growth.

"The only way to prevent accumulation of salt in soils under irrigation is to leach the root zone from time to time and thus carry the salt away. The theory of using as little water as possible, thus retarding salt deposition, only postpones the day of trouble. There should be no misunderstanding as to the purpose such a drainage system should serve. It should be so designed that it will not only remove surplus water from waterlogged areas, but also serve as the outlet for surplus salt from the root zone of the entire irrigated area . . . .

"The accumulation of salt in the soil solution of the root zone is one of the serious hazards in irrigation farming. It is preventable by the provision of adequate drainage and by following a method of irrigation that will insure occasional effective soil leaching. We can not avoid using irrigation water that contains salt, but it is possible to operate an irrigation system in such a way that the injurious salts will be carried away in the drainage as rapidly as they are brought in by the irrigation water. When that is done there is likely to be little ground for apprehension as to the future productivity of the soil."

What Agriculture Can Learn from Urban Industry*

By O. B. Zimmerman[1]

IN WHATEVER field engineering interests itself it makes a point to study the underlying factors affecting waste. This is done with a view of reducing waste to the minimum. Some years ago waste in industry was made an intensive study resulting in then thought unbelievable reduction in these losses, and now the same kind of effort is under way with respect to agriculture.

Waste in agriculture has received special attention in minor ways, but in a large way so much is still to be done and with benefits so great, that all interested must give heed.

Where then can we look for guidance in this huge problem? One procedure undoubtedly is the engineering approach to the problem. And why do we term it the engineering approach? Because that means that there will be used every facility of the science of engineering and the natural sciences to further the problem; it assures a sane, a thorough analysis. It means fairness of the deductions; it means the problem will be handled on the square. So it is logical and good sense to see in what ways the principles of waste elimination, which were so successful in well-engineered industry, can be adopted in well-organized agriculture.

If we were to ask one hundred farmers what they can learn from industrial management, it is probable that ninety per cent of them would say, "Something but not much, because our problems are so different." We are sure, however, that the answer should be the reverse as to percentage.

Waste, in the large sense here used, is not alone such losses as the grain scattered along the miles of road from the farm to market due to a leaky wagon box. It is not alone the rotting mass of fruit on the ground in the orchard; the seeping away of the valuable liquids in the barnyard; the rearing of unsuitable livestock, and similar losses all along the line, but it has to deal as well with management problems throughout the year. In management I believe is where the greatest waste will be found.

By comparison the crop-growing activity taken alone on the farm has less chance to be one hundred per cent efficient than has the stock-raising activity, because while the first is seasonal the latter is an all-year-round operation.

*An address before a meeting of the Structures Division of the American Society of Agricultural Engineers, at Chicago, December, 1927.

[1]Assistant to manager, experimental and engineering departments, International Harvester Company. Mem. A.S.A.E.

"For agricultural purposes, especially for the field or mobile units, we do not see at the present time," says Col. Zimmerman, "a better all-around source of power than the internal-combustion engine"

Industry in the cities has an ideal and is usually organized on the basis of three hundred days of work a year. Days of eight to ten hours of continuous and uniform production are desired whether the market for its products be seasonal or not. The crop farmer can on the average figure approximately two hundred days a year rain and shine for his field activities; hence, the balance of one hundred days must be profitably cared for in some other constructive manner, if a corresponding profit and income is to be attained. Without going into refined details here this useful time problem is a big subject for intensive study in agriculture. Think of the waste of human time, and that unprofitably occupied among those especially who raise one crop during a short-growing season.

Further with respect to time, not only is it desirable to aim at the full-time idea, but that time must be profitably occupied at a humanly possible rate of speed. In industry this feature is one given marked and minute attention and explains the high production per man-hour. It is not the man who is the noisiest, the man of many intense fancy motions who is accomplishing the most; it is the one whose every motion is quiet, logical, necessary and intensified or speeded up who covers the ground with the least expenditure of time and energy. Only by the use of organized, well thought out relations to all other operatives in the plant can the maximum be attained. Industry likewise supplies its operatives regularly with the latest and best of equipment and methods to permit of the greatest production per man-hour and per dollar spent or invested. So on the farm that equipment may be a machine or it may be the quality of stock raised or bred.

It is refreshing to see the corresponding efforts being made towards urging similar efficiencies on the farm and to note that whenever and wherever they are applied marked advantage comes to the manager. Note the splendid records attained by the livestock growers, in pork, beef, milk productions, the breeder of high-producing hens, ton-litter pigs, the grower of 100-bushel corn per acre and similar fine crops. None of these records are made by scrub or accidental stock or seed. These records are directly comparable to intensive special automatic tool operations in the urban shops. Anything less than an effort of the farmer to analyze the reasons why his farm just across the fence from Dick's doesn't produce somewhere near the same quantity is poor management, is poor engineering, is waste. So likewise the raising of scrub stock can never pay as well as better selected or bred animals. In industry when a machine cannot produce proportionally the quantity and quality product scheduled it is set aside. It must be scrapped in favor of the more efficient, even though far from being worn out. In the same way the boarding hen, the boarding cow, the old sheep must be set aside for economy's sake.

We should constantly set forth these fine records of the attainable and tell how they came about. Keeping these in view instead of trying to beat the average is the finest kind of stimulus to high profits.

The agricultural engineers are now giving much attention to farm structures, sanitation and other facilities which render much aid toward establishing efficiency and profit. How many horses, cattle, sheep, hogs, poultry are subject to inconvenient, cold and disagreeable housing, wherein their major energy during the winter months goes to just living through, fighting off the elements. Those are lost motions, lost time, hence real waste. The one who manages thus foots the bill of his inefficiency. Industry would no more expect to have its operatives produce results in a cold, damp, poorly lighted, heated and ventilated shop than can be. On the farm, in a good measure the livestock is your operative,

transforming material into salable products, and therefore deserves comparable treatment.

Livestock must be normally and constantly growing or producing—each hour, each day, each week. Every falling away, every delayed growth is waste and must record needless cost to the producer. It likewise has its definite effect on quality. It is comparable to a breakdown in a producing machine, be it a binder in the field or a machine tool in the shop.

Along these lines intensive research in agriculture is still necessary. We must analyze, record, measure these effects and translate them into intelligent data to present in the light of costs to the farmer and to the nation. Such data would then form the urge and reason for improvement of those facilities which will raise the efficiency and profit per man-hour and per dollar invested. That is an effort at elimination of waste.

Studies in feeds and feeding, now going on in the U. S. Department of Agriculture and in the experiment stations likewise are fine examples of applying science to agriculture comparable to similar successful and hugely profitable researches made in industry. The agricultural engineers then are ready and willing to cooperate in every way towards the solution of both major and minor problems of agriculture. These few thoughts give but an indication of what can be done and where and how they can help. Every branch of agriculture has its logical and useful part in our national prosperity, and we believe that our facilities, or method of approach covering all phases of the problem of waste in agriculture can result in great profit to the stock farmers of America as well as the crop growers.

A Self-Feeder of Simple Design and Low Cost

By Dean G. Carter[1]

THE department of agricultural engineering at the Arkansas agricultural experiment station has made a study of self-feeder construction in the effort to provide a simplified feeder design of low cost and simple construction. Brief study of published feeder plans indicates a variety of lengths, sizes and kinds of material. Sizes from 2x2-in. to 2x12-in. lumber were noted. Material lists for a single feeder call for lengths of 8, 10, 12, 14, and 16 ft. Other plans show some difficult or special construction such as slots in wood pieces, beveled edges, and long threaded bolts.

Many plans leave much to the imagination of the builder as to methods, cuts, and best use of material. It is difficult to explain the usual plan to one not familiar with construction drawings.

To produce a feeder that would meet the usual requirements of capacity, construction, protection, cleanliness and positive feed, and yet be as simple as possible in plan and construction, the following definite requirements were set up as to what the feeder should have:

1. A material list containing a minimum number of lengths of material
2. A minimum of kinds of material required
3. An exact figured bill of material
4. Construction that would allow precutting without waste
5. A minimum number of cuts
6. Unit construction, or erection by parts
7. A construction plan that could be explained step by step.

In order to meet these requirements it was necessary to establish dimensions for economy in cutting, to use stock lengths, to develop a construction method, and to make an exact step-by-step study of the materials and methods.

The accompanying drawings show the steps in the complete construction, each part considered separately. The requirements set up were met in the following manner:

Minimum Number of Lengths. If the feeder is made 6 ft. long, 3 ft. wide, and 3 ft. high, it has a nominal capacity of 25 to 30 bu. of feed. If the roof boards are made 3 ft. long, there is sufficient protection for the feed in the trough. The angle braces for the hopper and the roof rafters give the proper proportions when cut from 2-ft. pieces. Therefore, every piece of material used may be cut 2, 3 or 6 ft. long, and the material list requires but a single length, 6 ft., or one-half as many pieces 12 ft. long.

Minimum Kinds of Material. Two-by-four dimension material is most satisfactory for the framework. Considering the low cost, 1x8-in. shiplap was selected for the covering; 1x4-in. was selected for cleats and strips, making the total requirement three kinds of material: 1x4-in. frame, 1x8-in. covering, and 1x4-in. strips. Since only a few pieces of 1x4-in. are needed, it is entirely feasible to rip 1x8-in. boards for cleats, and reduce the feeder to two kinds of material.

Figured Bill of Material. It is evident from the plan that the exact number and lengths of pieces required can be figured exactly, avoiding waste material and eliminating guesswork.

Material Precut. The angle cuts on rafters and angle braces have been calculated exactly. All pieces for length, width and height are of a definite length. Notches in the studs and plates are of known size. The cutting can be done

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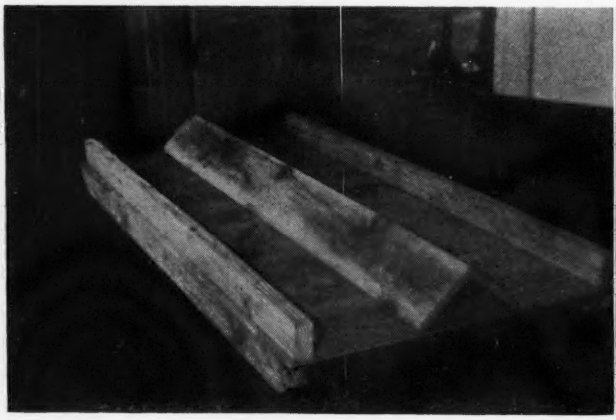
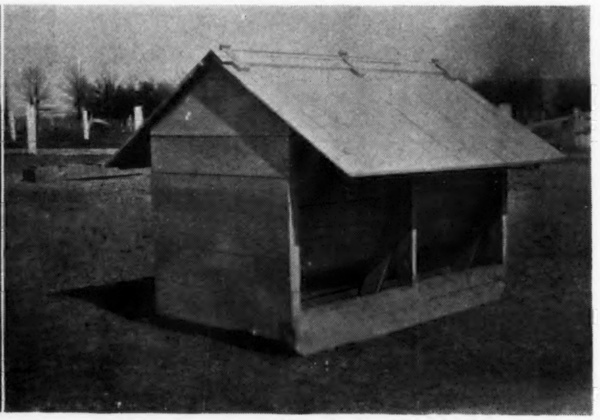




(Left) Base unit of Carter self-feeder. (Right) Simplified self-feeder designed by Mr. Carter

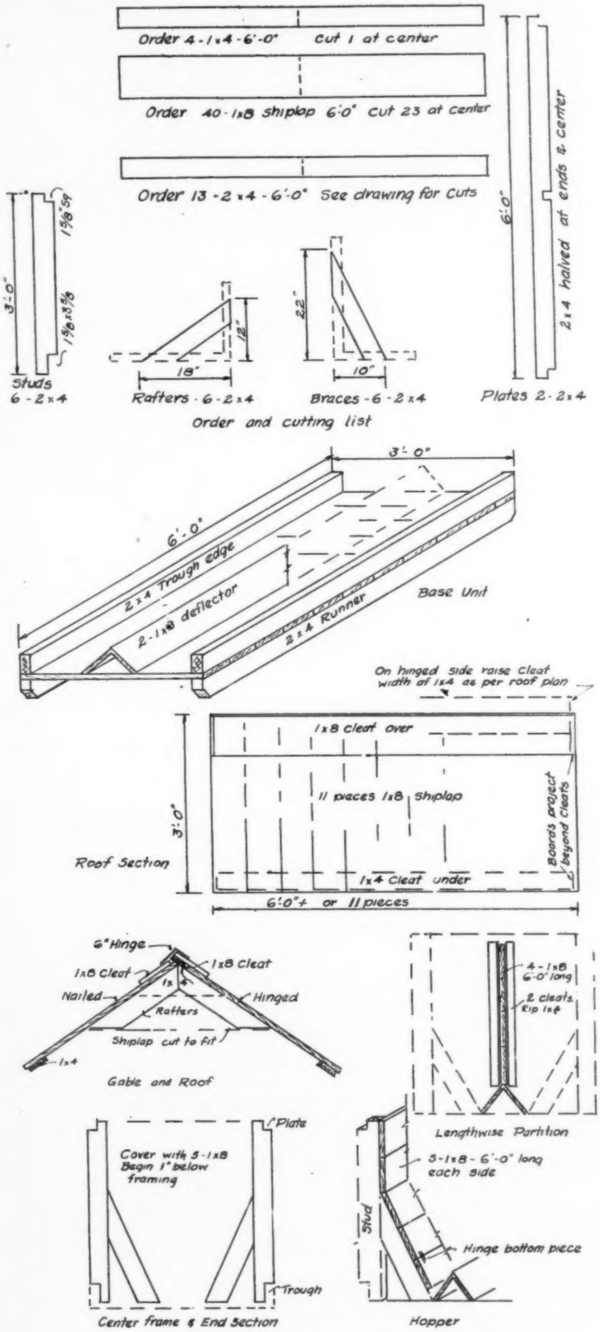
on a machine, or in quantity by hand thus reducing the labor cost.

Minimum Number of Cuts. Excepting only the studs and plates, which must be notched, and the gable end cover pieces which are marked and cut after the rafters are in place, each piece is cut to exact length and shape.

Unit Construction. The base, except the deflector, the two ends, and the two roof sections can be built as units, and the feeder can be assembled in a short time. The unit construction aids also in explaining each part of the feeder in an understandable way.

Step-by-Step Construction. This feature of the design is of particular interest in the application of the feeder to construction as a Smith-Hughes project, or in presentation to students or builders. The following list, although quite evident from the drawings, is given to indicate the completeness with which certain structures may be detailed as to method:

1. Order material
2. Cut all parts to fit (except gable ends)
3. Make base unit
4. Build end sections to plate
5. Fit end sections to base
6. Attach plates
7. Erect center pieces
8. Make deflector and fit between angle braces
9. Nail two boards inside studs at plate
10. Nail one board inside angle braces
11. Hinge bottom board to another 6-ft. piece and place both against angle brace
12. Complete opposite side of hopper in the same way
13. Place rafters and cover gable ends
14. Build tight roof section and attach
15. Nail 1x4-in. piece along ridge
16. Build hinged-roof section and attach
17. Add lengthwise partition for two compartments
18. Fit cross partition on one side if three compartments are desired. (This will necessitate dividing agitator board on one side.)



These drawings show the details of construction of the simplified self-feeder designed by D. G. Carter

CONSTRUCTION PROCEDURE

If the design of a feeder is to be completely simplified, and each part made clear to the builder, then it must lend itself to a construction that is specific and easily possible. The following processes conform to the illustrations showing the units of construction:

Base. Bevel the ends of two 6-ft. 2x4-in. pieces. Set down on level floor 3 ft. apart. Begin at one end and tack one piece of 1x8-in. shiplap. Square frame and floor entire length of runners. It will be necessary to rip one piece of 1x8-in. to come even. Nail 2x4-in. pieces for trough edge directly over runners.

End. Square two pieces of studding and two angle braces on floor or table; begin 1 in. below bottom with shiplap, and put on five pieces. Make second end in the same manner.

Tight Roof Section. Square up eleven pieces of 1x8-in. with one 1x4-in. cleat under and one above at opposite ends, and nail.

Roof Door Section. Make the same as tight roof section but use 1x8-in. shiplap, extending half over ends of 3-ft. pieces for the upper cleat.

Hopper Sides. Nail two boards to studs on inside, and one to angle braces. Hinge two boards together, fit in on angle braces, and nail upper one. The hinged board should leave an opening about 1 or 1½ in. wide between it and deflector. It should also clear deflector when raised. It may be necessary to trim hinged board slightly to fit.

Deflector. Make from two pieces of 1x8-in., 6 ft. long, matched at the top, at almost right angles, but with the base just wide enough to fit into space between angle braces.

Long Partition. Nail two 1x2-in. or 1x4-in. cleats to ends, at center, with 1-in. space between, and drop four boards into the slot just over deflector.

Cross Partition. To make a three-compartment feeder it is necessary to divide one side of the feeder. This is done by cutting a partition to fit and dividing the agitator or hinged board on one side.

(AUTHOR'S NOTE: Our purpose in making the study, which resulted in the development of the simplified feeder described in the foregoing article, was to utilize short-length lumber, to reduce the cost to a minimum, and to make the construction simple yet practical for Smith-Hughes schools and farmer-builders who wish to do their own construction work. This type of feeder can readily be furnished by materials dealers and contractors who could cut all the material on a power saw. This feeder is now in use in the feedlots on the university farm and seems to meet the need satisfactorily.)

Recent Developments in Tillage Machinery*

By F. A. Wirt[1]

(Continued from April issue)

Part 2. The Stiff-Tooth Cultivator

In the northern Great Plains area the stiff-tooth cultivator is popular for many of the same reasons which have brought about the widespread use of the wheatland disk plow in the Southwest. For summer fallowing, moisture conservation, weed eradication and seedbed preparation the stiff-tooth cultivator is popular in western North Dakota, Montana and the western provinces of Canada, and in the wheat-growing sections of the Pacific Northwest. It has also been used in other states under similar conditions.

The name of this machine is obtained from its construction, sweeps usually being used at the end of a stiff bar—hence, stiff-tooth or duck-foot cultivator. It is also called a field cultivator. This same machine, however, can be equipped with spring teeth, which some believe are particularly well adapted to quack grass eradication, the stiff-tooth or duck-foot equipment being very popular for field cultivation and summer fallowing.

Please do not compare the chisel-tooth cultivator of California with the stiff-tooth cultivator of the Northwest.

In passing it should be explained that the regular stiff-tooth cultivator is equipped with a spring trip attachment which permits the shovels to pass over the material without damage, and then returns the shovels to work in position. The stiff-tooth construction carries with it individual spring release.

Machines are made in 5½, 6, 7, 7½, 8½, 9, 11½ and 12-ft. widths, the number of teeth varying with the different makes. The 5½ and 6-ft. machines can be equipped with three or four-horse hitch; the 7 or 7½ ft. with four-horse hitch; the 8½ and 9-ft. with four and six-horse hitch; while the 11½ and 12-ft. machines can be equipped with tractor hitch and power lift.

The shovels are in two rows, being attached to the framework in a very substantial manner in order that the machine can stand up under the conditions met with in the Northwest and Canada.

Some machines can be equipped with shovels of different widths. There seems to be quite a tendency to use shovels which are too narrow and then to operate the machine at too great a depth. For the purposes desired, it is much better to use wider shovels at shallow depths. This results in better weed elimination and prevents unnecessary loosening of soil.

Advantages of the Stiff-Tooth Cultivator

In operation the soil is not unduly pulverized, and if the shovels are lapped sufficiently all weeds are cut off; the surface is left ridged and cloddy, the fine soil being sifted to the seedbed below and the clods and trash either being brought to or kept at the surface. Where other machines, such as blade and rod weeders, cause trouble in glaciated soil because of rocks and gravel, the stiff-tooth cultivator is especially well adapted. The machine seldom clogs.

Where summer fallowing is practiced in the Northwest because the rainfall is insufficient, the duck-foot or stiff-tooth cultivator is a prime favorite. "When properly done," according to Mr. Hunter in the U.S.D.A. Farmers' Bulletin No. 1545-F, entitled "Dry Farming Methods and Practices in Wheat Growing in the Columbia and Snake River Basins," "it prevents the growth of weeds, checks evaporation, aids in the accumulation of nitrogen in the soil, and prepares an excellent seedbed for the germination of all sown wheat. Several methods of summer fallowing are practiced but that of plowing the land early in the spring and following with enough tillage to keep down the growth in weeds results in an increase in the yield of grain over all other methods."

While Mr. Hunter refers to conditions in the Columbia and Snake River basins, yet summer fallowing also has proved very successful in the spring wheat areas of the Northwest, largely for the same reasons. By plowing immediately after harvest and following with the stiff-tooth cultivator as often as needed to keep down the weeds and maintain a clod mulch most excellent seedbeds can be obtained.

In Montana they have found it possible to practice "plowless summer fallow."

One reason for the growing popularity of the practice of summer fallowing is found in the accumulation of available plant food resulting from a combination of moisture, air and heat conditions favorable to bacterial action.

To obtain maximum results in the conservation of moisture, it is necessary to have a good contact between the plowed furrows and the subsoil, the seedbed to be mellow but firm and the surface to have a clod mulch rather than a hard surface or dust mulch, for both of the latter are inefficient from the standpoint of absorbing moisture. Leaving the surface in a slightly cloddy condition, as does the duck-foot cultivator, the clod mulch is much less likely to puddle during a heavy or beating rain.

When a field is properly plowed in the spring and later in the summer tilled with a duck-foot cultivator, the seedbed should not be loose, open or dry; there should be no open spaces, very few if any weeds, and no dust mulch or baked surface. Such a seedbed, when in proper condition, will not only retain moisture that may fall, but will also prevent losses through direct evaporation and through weed growth.

While not as much trouble is experienced with soil blowing in the Northwest as in Kansas, yet summer tillage brings forward this very real problem. Soil blowing becomes more serious as continued growing of crops depletes virgin root fiber and organic matter. On soils that are likely to blow it is always advisable to have the trash and clods kept at the surface. For this the stiff-tooth cultivator is very effective.

Loud are the praises of the owners of this machine for its value in controlling weed pests. Growing vegetation is one of the greatest robbers of moisture. A weedy summer fallow is an abomination. The eradication of weeds is all important in summer fallowing or summer tillage. It is

Two McCormick-Deering 9-ft. cultivators equipped with stiff teeth and "duck foot" shovels, a popular combination for use in conditioning summer fallowed land. Each outfit is working approximately 30 acres a day. Where large acreages are to be covered, a tractor-drawn field cultivator keeps production costs down by making the best use of man labor. Even greater economies are possible with the 12-ft. cultivator

*Parts 2 and 3 of a paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, November, 1927. Part. 1 appeared in the April issue.

[1]Advertising manager, J. I. Case Threshing Machine Co., Racine, Wis. Mem. A.S.A.E.

A 13-ft. rod weeder. A rotating rod which works just beneath the surface of the ground pulls the weeds out by the roots

realized, of course, that to obtain best results the weeds should be killed when small and easily damaged. Spike-tooth harrows, disk harrows and other similar implements for this purpose have been tried but found wanting in the drier sections of the Northwest.

The duck-foot cultivator, however, is particularly effective in killing quack grass, sow thistle, stink weed and other equally damaging weeds.

The machine is very successful for the eradication of quack grass. Quack grass like other perennial pests spreads by seed and by sending up new shoots from its underground root system. Plowing and harrowing through the roots for instance only scatters the roots over the field, thereby increasing infestation. To eradicate quack grass the roots must be worked up out of the soil so that they can dry up or, if necessary, be raked and burned.

One excellent use is to cultivate shallow to kill weeds just before or at the time of planting. This practice is especially recommended when the spring is both cool and backward, or when conditions seem to favor weeds rather than the grain crop. Sometimes too the stiff-tooth cultivator and grain drill are hooked in tandem.

Some recommend the spring teeth attachment for quack grass rather than the stiff-tooth cultivator with wide shovels or sweeps.

When equipped with spring-tooth gangs and special quack grass teeth, the machine has been used successfully for the renovating of alfalfa. This form of cultivation is looked upon with favor and disfavor. At the present time there seems to be evidence both for and against the value of cultivating alfalfa.

For the eradication of weeds, the conservation of moisture, summer fallowing, and rapid preparation of the seedbed in fields which may contain rocks and gravel, and which require very effective utilization of all available moisture, there you will find the duck-foot cultivator of immense value to the farmer. This machine will become more popular as its value becomes more apparent.

Part 3. Rod and Blade Weeders

Another machine which has proven to be very satisfactory for the eradication of weeds and for summer fallowing purposes is the rod or blade weeder.

The rod weeder can be of double rod, single rod or goose neck slicker construction. Where the soil does not contain gravel or rock these weeders have proven to be quite satisfactory, many farmers using the combination of duck-foot and rod weeder.

A more recent development has been the rotary rod weeder in which a square continuous rod revolves beneath the surface of the ground. This action tears the roots of the weeds loose and pulverizes and mulches the soil.

Conclusions

From this very brief discussion of recent tillage tool developments it will be noticed that farmers in the winter wheat and spring wheat areas are striving to develop ways and means of increasing the production per man, of making their operations more efficient and therefore more profitable. While some of the machines referred to are not new in the sense of design or construction, yet they are new to many sections from the standpoint of utilization. Such development is continuing rapidly. It will be necessary for everyone interested in tillage tools for the growing of wheat to keep in very close contact with day by day developments. Tools that are satisfactory for many conditions, proven so by years of use, are not satisfactory to the progressive farmer in other sections where peculiar conditions demand a different soil treatment.

Much valuable information on stiff-tooth cultivators can be obtained from Montana Extension Service Bulletin No. 79, entitled "Summer Tillage Implements."

An Automatic Temperature Regulator for Poultry Houses

By Henry Giese[1]

ONE of the by-products of a research project on poultry house ventilation at the Iowa station has been the development of a hydraulic thermostat for manipulating the valves in the outlet flues of a ventilation system. Experience would seem to indicate that many a good ventilation system is rendered useless because of failure to operate the valves in the flues.

The working of this control is based on the assumption that in mild weather a large flow of air is permissable and that at low temperatures a smaller flow is advisable to prevent chilling the birds. The device consists of a butterfly valve operated by a hydraulic thermostat. This is placed in the outtake flue of a ventilation system. In mild weather the valve is wide open allowing a free flow of air. This assists in removing excess moisture and helps to avoid extremely high temperatures which would otherwise maintain. In severely cold weather or in cold windy weather, the butterfly closes thereby restricting the flow of air. While this may result in some accumulation of moisture within the pen, such periods are usually of relatively short duration and the birds are not chilled as they would otherwise be. The general effect is then to avoid extremes of temperature either high or low. This is accomplished without any attention on the part of the poultryman either to operate the valves, renew batteries, wind springs, etc.

The device consists of a butterfly valve placed in a ventilating flue and operated by means of a hydraulic thermostat. The mechanism connecting the thermostat with the butterfly is so arranged that the butterfly is in its open position at relatively high temperatures and closed at relatively low temperatures. However, once it is either open or closed, any further temperature change causes no further movement of the butterfly. The exact temperatures at which the butterfly is at its open or closed positions can be set at will. The butterfly is also locked in all positions.

The effect then is a tendency to eliminate temperature extremes in a farm building. In mild weather the butterfly opens allowing a free flow of air. In cold windy weather the butterfly closes, restricting the flow.

[1]Assistant agricultural engineer, Iowa Agricultural Experiment Station, Ames. Mem. A.S.A.E.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Operating the Ensilage Cutter with Electric Motor, O. E. Robey and E. C. Sauve (Michigan State Quarterly Bulletin, 10 (1927), No. 2, pp. 37-39, fig. 1).—Data on power costs of operating ensilage cutters with electricity are briefly presented. They indicate that the cost per ton varies between 65 and 99 cents. The best speed of operation was found to be from 525 to 550 r.p.m.

The German Farm Machinery Industry, Its Development, and Its Present Status [Trans. Title], R. Ahrens (Greifswald: L. Bamberg, 1926, pp. 174, fig. 1).—This report presents a large amount of data on the origin of the German farm machinery industry and on its development during the periods previous to and since 1914. An extensive bibliography of literature bearing on the subject is appended.

Cement Requirements for Some Concrete Mixes, H. Allen (Concrete [Chicago], Cement Mill Edition, 31 (1927), No. 5, pp. 13-17, figs. 2).—The cement requirements for certain concrete mixes are tabulated as developed at the Kansas State Testing Laboratory.

An Outline of Sewage Purification Studies at the Lawrence Experiment Station, H. W. Clark (Industrial and Engineering Chemistry, 19 (1927), No. 4, pp. 448-452).—The studies in progress at the station on sewage purification are outlined and discussed briefly.

A Southern Rural Rate, E. W. Ashmead (Electrical World, 90 (1927), No. 12, pp. 562-566, fig. 1).—This rural rate is outlined in detail in the form of a graduated service charge, based on customer density, with a low energy charge. Rural customers are classified into four density groups, and provision is made for seasonal features.

Electricity in Agriculture, C. Buschkiel (Elektrizitat in der Landwirtschaft. (Berlin: Walter de Gruyter, 1927, pp. XII + 171, figs. 185).—This book presents information on the application of electricity to agricultural practices. It contains chapters on electrotechnical facts, production of high tension electrical current, use of high tension electricity in agriculture, installation of electrical equipment, low tension electrical plats in agriculture, and answers to practical questions. Considerable working data are included.

The Fate of B. Coli and B. Aerogenes in Sewage Purification, H Heukelekian (Journal of Bacteriology, 14 (1927), No. 1, pp. 55-67, fig. 1).—Studies conducted at the New Jersey Experiment Stations on the factors which operate in the reduction of B. coli and B. aerogenes in a sewage disposal plant are reported.

A study made over a period of seven months on the distribution of these two organisms in the different units of a sewage disposal plant showed no significant differences between the relative numbers at a given date for a given unit. The weekly fluctuations were great, but the monthly averages showed that the numbers in the incoming sewage were lower in the winter months. Ordinarily, a material reduction of the numbers of these organisms does not take place in passing through an Imhoff tank, but a reliable and material reduction invariably does take place in the filter beds, averaging as high as 89 per cent of the original numbers. There is no further reduction in the final settling tanks, but sometimes an increase.

There is no correlation between solid removal and bacterial reduction in the different units. Whereas maximum removal of solids takes place in the tanks, the maximum reduction of B. coli and B. aerogenes takes place in the beds, with no corresponding decrease in solids. Their numbers are reduced in the beds due to unfavorable conditions for continued viability.

There is an increase in the numbers of these organisms in the effluent from the tanks as compared with the incoming sewage in winter months due to more suspended solids passing out of the tanks. The lower temperature causes a low rate of digestion in the tank which induces more of the liquid in the tanks to be displaced into the flow compartment and retards the reduction of these organisms in the tank.

It was found further that when fresh solids are digested without seeding the numbers of B. coli and B. aerogenes rise to a maximum within two days, after which they fall rapidly to a low level. This coincides with the increase in acidity due to the attack of available carbohydrates. It is suggested that the B. coli group is mainly responsible for the decomposition of available carbohydrates in the beginning, giving rise to high acidity, which in turn checks their own numbers.

With daily additions of fresh solids to ripe sludge the same relationship holds, namely, an increase in B. coli and B. aerogenes to a peak within a week or so, the level of the peak depending on the amount of fresh solids added. Their numbers decrease after this until an equilibrium is reached, the level of which is also controlled by the amount of material added.

Use of Dynamite for Deep Tillage, J. S. Cole, F. L. Kelso, E. Z. Russel, J. B. Shepherd, D. Stuart, and R. R. Graves (U. S. Department of Agriculture Technical Bulletin 17 (1927), pp. 21-25, fig. 1).—The results of a deep tillage experiment with dynamite on gumbo soil conducted at the U. S. Dry-land Field Station, Ardmore, S. Dak., from 1913 to 1920, inclusive, are reported, leading to the conclusion that no increase of yields can be expected either as an immediate or after effect of the use of explosives on this soil.

Agricultural Engineering Investigations at the Missouri Station, J. C. Wooley et al (Missouri Station Bulletin 256 (1927), pp. 40-44, fig. 1).—Data from investigations on the use of electricity in agriculture, the clearing of cutover lands, farm sewage disposal, farm structures, the draft of farm implements and the preservation of wood fence posts are briefly summarized.

In feed grinding with electrictiy it was found that the total operating expense, including interest and depreciation, was 8.7 cents per bushel.

Experiments with a rotary plow attachment for a tractor in which a machine was used to prepare a seedbed at one operation showed that a much greater number of weeds occurred in the rotary plowed plat. These were large weeds not located in the hills but quite generally distributed. Much difficulty was encountered in cultivating corn in a rotary plowed plat due to the mass of weeds so close to the surface.

In studies of wood fence post preservation, the varieties which seem to take treatment to the best advantage are black walnut, white oak, red oak, black oak, sassafras, red bud, Kentucky coffee bean, honey locust and black ash. The double tank treatment with creosote has been effective enough to make it worth while with these varieties. Apparently this treatment approximately doubles their serviceable life. Such woods as willow, maple and cottonwood do not justify the treatment.

Laboratory Tests of Orchard Heaters, A. H. Hoffman (California Station Bulletin 442 (1927), pp. 37, figs. 15).—The results of tests of nineteen orchard heaters, including a high and a low test in the open and a normal test indoors, are reported.

In general it was found that the methods commonly uesd by mechanical engineers for testing the performance characteristics of steam boiler furnaces and the like are inapplicable to orchard heaters for the reason that the latter, burning in the open, present an entirely different problem. It was therefore necessary to devise entirely new methods and apparatus.

The burning rate was found important, since it governs the rate of heat production. Each type of heater, if left without readjustment, was found to have a characteristic burning rate curve, the shape of which was altered by changes in wind velocity and air temperature and in temperature and volatility of the fuel. The burning rate is adjustable in most heaters. Too high a rate was found undesirable, since it tends to increase smoke and losses by radiation and by gases rising too high. It also tends to cause rapid scaling off and destruction of the stacks. Frequent and careful regulation is desirable as a means of overcoming the smoke nuisance as well as of securing the desired heat production.

From the standpoint of heat distribution and reduction in the amount of smoke, it was found better to light all of the heaters and burn them at a low rate with frequent regulation than to light only a portion at first and to light others as the night grows colder. This frequent regulation was found to control the burning rates of the heaters in such a way as to save considerable fuel. With briquet heaters the most practical method of controlling the burning rate is to start with a relatively small fuel charge and refuel at about two-hour intervals throughout the night.

All of the heaters were found to be practically 100 per cent efficient from the standpoint of converting fuel into heat. There was almost no carbon monoxide in the gases, and the heat lost in the unconsumed carbon of the smoke was in every case less than 0.1 of one per cent of the total heat in the fuel used. The heat radiated above the horizontal plane ranged from about one to nearly five per cent of the total heat in the fuel. Not all of this radiated heat is lost, since the portion that strikes leaves, twigs, or other opaque objects and is absorbed was found to warm the air. Baffles for decreasing the radiation loss were found practicable.

High upward velocities and high temperatures tended to waste fuel by sending the hot gases to high levels above the orchard. The velocities found were satisfactorily low except in high stack heaters not equipped with a horizontal baffle plate. Velocities as high as 14 ft. per sec. were found in some of these.

Smoke was found to be of little or no benefit as a blanket to prevent radiation. The lard pail heaters were the worst offenders in this respect. A number of the later oil burners were practically smokeless when burned at normal and low rates, but all smoked some when burning at very high rates. Oils, being higher in heat content per pound, were found to be more effective than solid fuels. High sulfur content in fuels was found to be objectionable, and high viscosity and rapid increase in viscosity when the temperature decreases make an oil unsuitable for nondistilling type heaters.

Refrigeration in the Chemical Industry, G. W. Daniels (New York: D. Van Nostrand Co., 1926, pp. [6] + 141, figs. 39).—The scope of this book is such as to permit the formation of some correct quantitative ideas of the capabilities of refrigerating plants and of the amount of refrigeration necessary for a given purpose. It contains chapters on some fundamental points, properties of refrigerants in use, calculation of capacity and power, calling for tenders, choice of a machine, condensers, cooling of liquids, cooling of gases, insulation, operation of refrigerating plant, choice of a prime mover, and chemical processes using refrigeration.

Some Studies of Infiltration of Air Through Windows, A. C. Armstrong (Journal of American Society of Heating and Ventilating Engineers, 33 (1927), No. 7, pp. 423-433, figs. 8).—Studies are reported which were concerned principally with the problem of the infiltration of air through windows, and a review of the work of others bearing on features of the subject is included. The studies were devoted primarily to typical metal windows, including seventeen different types. The results are presented both graphically and in tabular form, but no conclusions are drawn.

New Methods of Dry Land Cultivation [trans. title], M. de Arana y Franco (Nuevos Metodas de Cultivo en Secano [Madrid]: Ramona Velasco, [1925], pp. 295, figs. 122).—Methods and machinery used in dry land farming in Spain are described and discussed in considerable detail. Apparently the machinery used is practically the same as that used in American dry farming.

The Determination of the Duty and Control of Irrigation Water, G. H. W. Barnhart (Association Hawaiian Sugar Technological Report, 5 (1926), pp. 106-120, figs. 8).—Experiments on the duty and control of irrigation water are reported which demonstrated the values of shorter intervals between irrigations in the better growing months. Considerable data are reported from which no conclusions are drawn.

Stream Pollution in Wisconsin (Madison: Wisconsin State Board of Health, 1927, pp. XVIII + 328, figs. 86).—This is a joint report of the Conservation Commission and the State Board of Health of Wisconsin concerning their activites in the control of stream pollution from July 1, 1925, to December 31, 1926.

The data reported indicate that the discharge of industrial waste into certain streams is the only practical method of ultimate disposal in many cases, and constitutes a necessary and proper use of the stream, provided the dilution is so great that there is no menace to public health nor material interference with the natural aquatic life of the stream.

Nearly all wastes cause reduction of the dissolved oxygen of the stream, and industrial wastes generally have a greater oxygen demand than domestic sewage. Biological oxidation is more rapid during warm weather than during cold weather, so that the oxygen demand of the waste is greater although the actual amount of xygen available is less, because warm water retains less oxygen in solution. When the dissolved oxygen of a stream is depleted, green plants and other grasses of aerobic life die and anaerobic organisms such as worms and lower animal life prevail. A stream tends to purify itself by natural processes and will ultimately return practically to normal if the concentration of the wastes is not too great.

The results of an experimental investigation concerning the efficiency and practicability of chemical treatment in removing substances from pea cannery wastes that cause local nuisances and objectionable stream pollution showed that by careful operation and the application of about 3.25 lb. of ferrous sulfate and 7.25 lb. of lime per 1,000 gal. of waste the oxygen demand can be reduced approximately 75 per cent. If the sludge is allowed to accumulate in the tank the oxygen demand reduction averages only 34 per cent, because the precipitated organic matter goes partially into solution and is carried through the tank. Aeration of the tank effluent will effect a further reduction in the oxygen demand, approximately 50 per cent being indicated by laboratory tests. The chemical treatment will materially reduce stream pollution and prevent local nuisances created by pea cannery wastes.

Studies in the treatment of sulfite waste liquor from pulp and paper mills to reduce its oxygen demand in the control of stream pollution showed that ponding and aeration of the waste will effect a very material reduction in its oxygen demand. Mechanical aeration will also reduce the oxygen demand.

Data from stream pollution surveys are also included.

Efficiency Test for Radiator-Fan-Type Air-Cleaners, A. H. Hoffman (Journal Society of Automotive Engineers, 21 (1927), No. 1, pp. 82-86, figs. 6).—The progress results of studies being conducted at the California Experiment Station are reported. In the course of these experiments a special method of testing air cleaners of the radiator fan type was found necessary, in which the air cleaner is mounted in its normal position behind a radiator fan located inside of an elliptical wind tunnel within which the fan circulates air. A tractor engine running at constant speed and load drives the fan and draws the air for its carburetor from the wind tunnel through the air cleaner under test and from an absolute air cleaner connected in series.

A 100-gram charge of a standardized dust is introduced into the wind tunnel. By averaging the results obtained from repeated tests, using three different collecting-type dry centrifugal air cleaners, it was found that under normal conditions 15 per cent of the total dust charge actually reaches the air cleaner under test in the apparatus. Therefore, 15 grams is the basis on which the efficiencies of dust separation are calculated. With one exception, the air cleaners tested showed rather low efficiency. The vacuum or restriction effects were found to be low and were unaffected by accumulation of dust except in two cases.

Overhead Irrigation, K. D. Bond (Association Hawaii, Sugar Technological Report, 5 (1926), pp. 93-105, figs. 2).—Data from experiments with overhead irrigation are reported which showed that the saving in labor per crop will pay for the installation on the assumption that yields under sprinklers are no more than equal to those from contour fields. Equalization of pressure along the lateral is necessary to obtain proper distribution.

Draw-bar Tests at Peradeniya, T. H. Holland and L. Lord (Tropical Agriculture [Ceylon], 69 (1927), No. 2, pp. 76-84, pls. 4).—The results of drawbar tests of various agricultural implements conducted at the experiment station at Peradeniya are tabulated and discussed.

For dry cultivation of other than cocoanut estates, an all-steel moldboard plow was found to give the best results. It was also best for use on cocoanut estates for plowing in heavy weed growth or green manures. The disk harrow was found to be the most effective implement for shallow cultivation. For the first plowing of paddy, where there is a strong weed growth or green manure to plow in, a wooden beam plow with wheel is recommended for use with average cattle. With cattle above the average in size, the all-steel plow is recommended. Thorough harrowing with a Burmese harrow is recommended as a substitute for mud plowing.

Power and Labor Studies (Pennsylvania Station Bulletin 213 (1927), p. 23).—It is reported by H. B. Josephson that in potato growing the labor required in picking the potatoes off the ground and loading them into a wagon was found to be over 40 per cent of the total labor requirement for producing the crop. It was also found that the amount of plowing accomplished with tractors in stony fields was less than two-thirds of that done in fields where there were only a few rocks.

Agricultural Engineering Studies at the Arkansas Station (Arkansas Station Bulletin 221 (1927), pp. 5-7, fig. 1).—In plow draft tests under several soil conditions it was found that there was very little difference in the draft per square inch within the range of cut of from 10 to 30 in. in width. With but one exception the draft was heaviest in cotton stubble and lowest in soybeans. Cowpea stubble and sod were intermediate. In 275 tests it was shown that the draft per square inch of furrow section is inversely proportional to the depth of cut.

In an analysis of the use of machinery in cotton production the conclusion was reached that power and labor represent about two-thirds of the cost of production and offer an opportunity for a critical study of methods.

In studies of the durability of posts it was found that oak posts butt treated with hot and cold creosote baths were still fit for service after 4 years. After 6 years with the same treatment, however, 16.8 per cent were rotted off. Of green oak posts treated two hours by the open tank process 23 per cent were rotted after 3 years. Painted steel posts were rusted after 4 years but still serviceable, while galvanized steel posts were in good condition.

Data on the number, size and duty of tractors on rice farms are also included.

Book Review

"Safety and Production" is the title of the report on this subject by American Engineering Council. It is an engineering and statistical study of the relationship between industrial safety and production. The book contains over 400 pages and nearly 300 charts. It is divided into three parts. Part 1 contains chapters as follows: Statement of the problem, findings of the committee, recommendations of the committee, and digest of the report. Part 2 contains chapters on levels of performance, increased productivity and reduction of action, accidents in terms of production, and individual accidents. Part 3 includes accident and production data obtained from the following industries: Cement; chemical; coal mining; coke; electric light and power; electric railway; gas; iron and steel; machine building and metal working; mineral mining; paper, pulp and paper products; quarry; steam railway; telephone and telegraph; textile, and woodworking. The publisher of this work is Harper & Brothers, 49 East 33rd St., New York, N. Y. The price is $5.00 postpaid.

"How to Get the Most From Your Tractor," is the title of a booklet just issued by the International Harvester Company of America, Chicago, containing much helpful information on the operation of the internal-combustion tractor. The booklet has been prepared for the purpose of helping especially the thousands of new and inexperienced users of gas engines by explaining the causes of irregularities in engine operation, most of which are minor details to the expert but which to the novice mean "trouble." It is not intended as an instruction book similar to that furnished by a tractor manufacturer. It covers points common to the operation of practically all makes of engines. It covers such subjects as starting troubles, ignition systems, fuel systems, backfiring, exhaust, explosion, missing, loss of power, irregular speed, overheating, smoke, excessive wear, knocking, and slipping. Copies may be secured free on request to the publisher.

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RAYMOND OLNEY, Editor

Critical Scrutiny of Research Projects

THE Committee on Experiment Station Organization and Policy of the Land Grant College Association states in its report presented to the Association in November, 1927, at Chicago, that there is still opportunity for improvement and still need for more careful scrutiny on the part of project leaders and administrative officers of experiment stations outlining new research projects, so as to insure concrete investigations of such limited range as to make them feasible of accomplishment within reasonable time.

It is pointed out in the report of this Committee that the authorization of new projects merits the most careful consideration and cooperation of the research leader and his co-workers with the responsible administrative officers in narrowing the proposed investigation to a concrete phase of a problem, looking to conclusions with minimum qualifications.

Emphasis is laid by the Committee on the fact that whatever the method of procedure, the leader of the proposed project should assume responsibility for knowledge and analysis of previous investigation or investigations under way, which may have a bearing on the research proposed by him. In like manner he should be prepared to support his proposed methods of investigation as adequate for accomplishment in the research proposed and feasible of being carried out with the facilities and equipment which may be made available.

After thorough consideration of these matters, the next important task is to formulate a project statement which pictures the merits of the project, its objective, procedure in the proposed investigation as to technique and methods, the probable period of time, and the funds required.

The Land Grant College Association committee, therefore, recommends as a policy to research workers and responsible administrative officers more careful scrutiny of new projects, keeping in mind the following:

The Title. This should characterize the concrete, limited unit of work to be undertaken and should not cover the entire field to which the project is related.

The Objective. It should be clear cut and specific, and not involved with statements of procedure.

The Outlook. The project should be constructive in character. It should take account of the status of the question, attack points which need further study, supplement other work, exhibit vision and ingenuity, and give prospect of success.

What, specifically, is it proposed to add to the sum of knowledge of the subject? Such a contribution may deal with some new point, or one still in doubt, or determine applications to the conditions in the region.

The Procedure. It should be up-to-date, representing the progress and current views on methods and technique. It should give data that will stand statistical analysis and be comparable with other similar accepted data. Does it cover the requirements of the subject, or is it one-sided or inadequate in some respects?

Thoroughness. The project should be designed to undertake thoroughly and with reasonable completeness the investigation of the subject and should not be fragmentary and superficial.

Probable Duration. Is the time element a reasonable one? Does the project commit the station to a course it may not be desirable to carry through?

The Funds Required. Is the estimate ample for the proposed investigation? Are the expenses and other essentials within the means of the station budget?

It is interesting to note that this Committee on Experiment Station Organization and Policy of the Land Grant College Association includes five leading experiment station directors, one of whom is chairman.

Objectives

"TO DEVELOP individual and group leadership based on higher efficiency, greater productive capacity and better operating practices among those engaged in the production of raw materials for food, shelter and clothing, through the application and use of engineering principles in agriculture."

The foregoing expresses briefly the objectives of agricultural engineers as set forth by the American Society of Agricultural Engineers.

It is important to note that mention is made first of the need to develop individual and group leadership. Agriculture is at the point where it is ready to adopt on a far larger scale than heretofore the means which engineers have provided—engineered methods and equipment. But "industrial leaders" are needed in agriculture, as much as in manufacturing and transportation, to put these means to the most productive and profitable use. We have a large number of such leaders now—men like Campbell, Murphy, Grubb, Mills, Bonebright, Fisher, Hardison, Magee, and others equally outstanding but too numerous to mention—but they are scarcely a drop in the bucket when the needs of the giant industry of agriculture are comprehended. Many more like them must be developed.

One of the greatest services A.S.A.E. can render to agriculture is to give all possible aid and encouragement to the development of the needed leadership—along with accomplishing in a general way the objectives it has set up.

"New Hired Man"

HOW engineers can do for the farmer the things that have made other industries prosper is clearly and comprehensively set forth in a recent issue of "The Country Gentleman," in an article, entitled "The Farmer's New Hired Man," by Arthur Huntington, first vice-president of the American Society of Agricultural Engineers. The following quotation from this article is significant:

"To industrialize agriculture to the point where it can compete as a producer and consumer with equal production, business practices and living standards, with an industrialized commercial and manufacturing world with which it must exchange its products"—that is the job of the "farmer's new hired man," who as the author points out is the agricultural engineer.

It is a tremendous job to be sure, but the agricultural engineer accepts it eagerly, confidently. Engineering, in combination with management and finance, is indeed the key to the development of an "industrialized agriculture."

Who's Who in Agricultural Engineering

D. G. Carter

C. O. Reed

O. V. P. Stout

Max E. Cook

D. G. Carter

Deane Carter (Mem. A.S.A.E.) is second vice-president of the American Society of Agricultural Engineers, and immediate past-chairman of the Structures Division of the Society. He is professor of agricultural engineering, and head of the department, at the University of Arkansas, Fayetteville. His specialty is farm structures; he is one of the recognized leaders in this branch of the agricultural engineering profession. Elsewhere in this issue will be found a short article by him on a self-feeder he has recently designed. He is in charge this year of the design and construction of $100,000 worth of buildings on the experiment station farms of the University of Arkansas; in other words, he is combining his work in teaching and research in farm structures with practical building problems.

Mr. Carter is a graduate in agricultural engineering of Iowa State College. On graduation he became associated with the James Manufacturing Co., manufacturers of farm building equipment. He was later instructor in agricultural engineering at Iowa State College, and the University of Missouri. For one year he was assistant professor in charge of organizing the agricultural engineering department at North Carolina State College. For two years he operated his own farm in Iowa, and in November, 1922, took the position which he now holds.

C. O. Reed

Chester Reed (Mem. A.S.A.E.)—a member of the Council of the American Society of Agricultural Engineers—is professor of agricultural engineering in charge of instruction and research in farm field machinery, Ohio State University. He is also advisory engineer to the engineering division of the U.S.D.A. corn borer control forces. His specialty is farm machinery; he occupies an outstanding position in that branch of agricultural engineering. When the entomologists, in their heroic efforts to stem the tide of the European corn borer invasion, decided to call in the agricultural engineers, Mr. Reed was one of the first to be called. He was in charge of the engineering and maintenance division of the U.S.D.A. clean-up forces during the season of 1927. His part in organizing and directing the engineering phases of corn borer control work will go down in history as one of the really great contributions to that effort.

Mr. Reed is a graduate of the University of Illinois, where following graduation he served six years as an instructor in field machinery. He was later agricultural representative of the George Batten Company, advertising agents, and advertising manager, head of the bureau of investigation and research, and divisional sales manager, respectively, of the Samson Tractor Division of General Motors Corporation. He has held his present position since 1922. He served as secretary of A.S.A.E. in 1911 and 1912.

O. V. P. Stout

Major Stout (Hon. Mem. A.S.A.E.) has just been elected an honorary member of the American Society of Agricultural Engineers—an honor which he richly deserves. His early vision of the tremendous possibilities of engineering as applied to agriculture and his active support of this branch of engineering in embryo is one of the outstanding milestones in the advance of agricultural engineering. As dean of the college of engineering at the University of Nebraska, he played an important part in the establishment of a department of agricultural engineering at that institution, which was the first in this country to offer work in that subject. In fact, throughout his connection with the University of Nebraska, Dean Stout—as his former students call him—was very active in behalf of agricultural engineering, but especially so during his term as dean of engineering. During recent years he has shown even keener interest in promoting agricultural engineering. He is very proud of the fact that he "helped raise" four A.S.A.E. presidents—J. B. Davidson (the first), L. W. Chase, F. A. Wirt, and O. W. Sjogren. He served the American Society of Agricultural Engineers as chairman of the Land Reclamation Division in 1925-26. He has taken a prominent part in the activities of the Pacific Coast Section. (An account of Major Stout's professional activities appears alsewhere in this issue.)

Max E. Cook

Max Cook (Mem. A.S.A.E.) is farmstead engineer of the California Redwood Association, San Francisco. His specialty is farmstead engineering, with particular emphasis on the development and design of farm structures. He is one of the recognized leaders in this branch of agricultural engineering. He is prominent in the activities of the Pacific Coast Section of the American Society of Agricultural Engineers, as well as the recently created Consulting Engineers Division of the Society. He has held a number of important committee appointments in the Society.

For over thirteen years Mr. Cook was associated with a San Francisco architect, being in full charge of the office for ten years of that time. He acted as chief draftsman and building superintendent and wrote all specifications, obtained bids and drafted contracts. For nearly ten years—until taking his present position—he was in the employ of the California Land Settlement Board as farmstead engineer, in charge of all building work and the layout of individual farmsteads at the Durham and Delhi land settlement colonies. In this work he directed the development of about three hundred farms. This work required a complete architectural training together with a knowledge of and a genuine sympathy for rural people, conditions, and requirements.

Tentative Program of the 22nd Annual Meeting
of the
American Society of Agricultural Engineers
Hamilton Hotel, Washington, D. C.—June 19 to 22, 1928

Preliminary Meetings, Monday, June 18

6:00 P.M. Meeting of the Council (Both incoming and outgoing members)

First Day — Tuesday, June 19

FORENOON

8:00 A.M. Reception, registration, etc.

College Division Program

9:30 A.M. Resident Workers Session

H. B. Walker presiding

1. Trends in Professional Agricultural Engineering Education—Q. C. Ayres, associate professor of agricultural engineering, Iowa State College

Discussion

2. Student Relations of the Agricultural Engineering Profession as a Factor in its Advancement—Ralph A. Palmer, assistant secretary, American Society of Agricultural Engineers

Discussion

3. "The Confessor"—The House Organ of Agricultural Engineering Education—E. R. Jones, professor of agricultural engineering, University of Wisconsin

Discussion

4. Committee Reports (on subjects not covered elsewhere on program)
   (a) Cooperative Relations—J. B. Davidson
   (b) Farm Machinery Instruction—A. J. Schwantes
   (c) Farm Mechanics in Secondary Schools—B. B. Robb

9:30 A.M. Extension Workers Session

L. F. Livingston presiding

1. A Formula for Effective Extension Teaching—H. W. Hochbaum, U. S. Department of Agriculture
2. Report of the Committee on Agricultural Engineering Extension—L. A. Jones

AFTERNOON

2:00 P.M. Resident and Extension Workers Joint Session

H. B. Walker presiding

1. The Effect of Industrial Progress on Educational Methods in Land Grant Colleges—Dr. R. A. Pearson, president, University of Maryland
2. The Development of Research Programs and Research Workers—Dr. Harrison E. Howe, editor, Industrial and Engineering Chemistry
3. Trends in Extension Methods—Dr. C. B. Smith, U.S. Department of Agriculture
4. Business Session

EVENING

8:00 P.M. Round Table Sessions

1. Land Clearing Group
2. Consulting Agricultural Engineers

Second Day — Wednesday, June 20

FORENOON

9:30 A.M. General Session

O. B. Zimmerman, president, presiding

1. Meeting called to order by S. H. McCrory, chairman, 1928 Meetings Committee
2. The President's Annual Address—Col. O. B. Zimmerman, assistant to manager, engineering department, International Harvester Company.
3. The Jewish Land Settlements in Palestine—Dr. Elwood Mead, commissioner of reclamation, U. S. Department of the Interior.
4. Agricultural Engineering in Europe—Dr. Hermann Schildknecht, division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture

AFTERNOON

2:00 P.M. General Session

O. B. Zimmerman, president, presiding

1. Progress in Agricultural Engineering—Philip S. Rose, editor, "The Country Gentleman"
2. Rural Sanitation—Dr. L. L. Lumsden, senior surgeon, U. S. Public Health Service
3. Extension Methods in Agriculture—Dr. C. W. Warburton, director of extension work, U. S. Department of Agriculture
4. Agricultural Engineering and the Master Farmers—H. H. Musselman, professor of agricultural engineering, Michigan State College

EVENING

8:00 P.M. Annual Business Meeting

Third Day — Thursday, June 21

(Simultaneous Sessions of the Technical Divisions)

FORENOON

9:30 A.M. Power and Machinery Session

L. J. Fletcher presiding

1. SYMPOSIUM—Hay Making Methods and Equipment—Discussions by engineers representing farm equipment manufacturers and college agricultural engineering departments, and by farmers and dairymen
2. Research in Power and Machinery, 1927—R. W. Trullinger, agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture

9:30 A.M. Rural Electric Session

E. A. White presiding

1. The Organization of an Electric Light and Power Company for Rural Development—G. C. Neff, general manager, Wisconsin Power & Light Company
2. The General Purpose Motor—Its Requirements and Possibilities—Charles P. Wagner, Northern States Power Company
3. Electric Characteristics of Rural Lines—Frank D. Paine, professor of electrical engineering, Iowa State College
4. Extension Methods for Rural Electrification—H. B. Walker, professor of agricultural engineering, Kansas State Agricultural College
5. Recent Developments in Rural Rates—E. A. Holloway, sales engineer, Iowa Railway and Light Corporation

9:30 A.M. Structures Session

W. G. Kaiser presiding

1. Control of Ventilation and Heat in Curing Sweet Potatoes—S. P. Lyle, professor of agricultural engineering, University of Georgia
2. Protection Against Termites—Dr. Thomas E. Snyder, entomologist, U. S. Department of Agriculture
3. The Place of the Water System in Economical Farm Development—F. C. Fenton, associate professor of agricultural engineering, Iowa State College

9:30 A.M. Land Reclamation Session

Geo. S. Knapp presiding

1. SYMPOSIUM—The Control of Soil Erosion—Led by I. D. Wood, extension agricultural engineer, University of Nebraska. Chairman, A.S.A.E. Committee on Soil Erosion
2. Recent Developments in Soil Erosion—F. O. Bartel, associate drainage engineer, U. S. Department of Agriculture
3. Report of Committee on Drainage in Humid Regions—E. R. Jones

AFTERNOON

2:00 P.M. Power and Machinery Session

L. J. Fletcher presiding

1. Research—A Major Activity of Farm Equipment Manufacturers—Arthur W. Turner, International Harvester Company
2. Requirements of Machinery for Handling Corn Stalks—J. B. Davidson, professor of agricultural engineering, Iowa State College, and E. V. Collins, agricultural engineer, Iowa Agricultural Experiment Station
3. Recent Developments in Machinery for Truck Crop Production—R. U. Blasingame, professor of farm machinery, Pennsylvania State College
4. Progress Report on Implement Wear Studies—A.H. Hoffman, research specialist in agricultural engineering, University of California
5. Duty of Cultivating Equipment—D. B. Lucas, assistant professor of agricultural engineering, Rutgers University
6. Research Work of the Bureau of Standards on Lubrication—M. D. Hersey, Bureau of Standards, U. S. Department of Commerce.
7. Business Session

2:00 P.M. Rural Electric Session

E. A. White presiding

1. Research in Rural Electrification, 1927—R. W. Trullinger

Round Table: Electricity in the Farm Home

2. General—Mrs. John D. Sherman, president, General Federation of Women's Clubs
3. Cooking—Miss Eloise Davison, home economics specialist, National Electric Light Association
4. Refrigeration—E. C. Easter, agricultural engineer, Alabama Power Company
5. Water Supply—H. J. Gallagher, Michigan Agricultural Experiment Station
6. DISCUSSION—Led by Dr. Louise Stanley, chief, Bureau of Home Economics, U. S. Department of Agriculture
7. Business Session

2:00 P.M. Structures Session

1. Research in Structures, 1927—R. W. Trullinger, agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture
2. Labor Economy in Dairy Management—I. F. Hall, department of agricultural economics and farm management, Cornell University
3. Business Session

2:00 P.M. Land Reclamation Session

Geo. S. Knapp presiding

1. Research in Land Reclamation, 1927—R. W. Trullinger, agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture
2. Committee Reports
   - (a) Drainage of Irrigated Lands—J. C. Marr
   - (b) Forestry—L. F. Livingston
   - (c) Irrigation—H. E. Murdock
   - (d) Land Clearing—A. J. Schwantes
   - (e) Land Settlement—Geo. C. Kreutzer
   - (f) Runoff from Agricultural Lands—C. E. Ramser
   - (g) Soil Hydraulics—S. A. Norling
3. Business Session

EVENING

7:00 P.M. Annual Banquet

William Aitkenhead, toastmaster

Fourth Day — Friday, June 22

FORENOON

9:30 A.M. General Session

O. B. Zimmerman, president, presiding

1. Land Development—Dr. I. O. Schaub, dean, North Carolina State College of Agriculture
2. Advertising as it Relates to Agricultural Engineering— K. J. T. Ekblaw, vice-president, Frank B. White Company

AFTERNOON

2:00 P.M. Sight-Seeing Trip

EVENING

8:00 P.M. Council Meeting

A National Rural Electric Project

A MORE complete and extensive investigation of the possibilities of rural electrification than ever attempted heretofore has been planned as a five-year project by a powerful group of national and eastern interests.

A practical laboratory of several electrified farms is to be established in Maryland within easy driving distance of Washington, D.C., on a national highway, and an exhibition building will be located at the University of Maryland, College Park, Maryland. The conduct of the project is to be under the joint direction of the National Committee on the Relation of Electricity to Agriculture and the Maryland committee.

Several experiments which none of the state committees have been able to work on extensively are to be undertaken in connection with the national project. The possibilities of being able to use electricity economically for hay drying, refrigeration, stationary spraying, soil treatment and insect control are all considered worthy of thorough investigation.

Six or eight farms in a group are to form the main experimental base. A few other farms may be added to the group on account of their adaptability to one or more of the major experiments named above. One farm may be rented or bought to give complete freedom to the investigators.

The best authorities on farm wiring will design the wiring systems for these farms, and the lighting will be planned in a similar manner. High standards in wiring and illumination are to be maintained at the lowest possible cost. The farms will be fully equipped, particular attention being paid to the application of electricity to agriculture under conditions typical of Maryland.

College Park, the site of the exhibition building, is just a few miles out of Washington on national highway Number One and is passed by millions of automobiles every year. As many farmers from every state in the union tour past this place, the location of the exhibition is ideal. The building will be made the center of rural electric information and literature as provided by the national and various state projects. Exhibits will illustrate the applications which are made on the project farms.

By obtaining this information and making it available to the farmer it is hoped to encourage him in the profitable application of electricity in large enough amounts so that he may also enjoy the advantages of low rates.

Leading sponsors of the project are the U. S. Department of Agriculture, Committee on the Relation of Electricity to Agriculture, National Electric Light Association, the University of Maryland, farm organizations, women's organizations, and electric power companies of Maryland.

Hopcalite

HOPCALITE, a catalytic agent which is used in various ways to provide protection against dangerous concentrations of carbon monoxide, oxidizes this poisonous gas, in the presence of air, into carbon dioxide, a relatively harmless gas, and will continue to do so indefinitely as long as it is protected from moisture. This mixture of copper and manganese oxides is already five years old, but still many deaths occur annually which could have been prevented by its use. Ordinary gas masks are no protection against carbon monoxide. A pocketsize respirator called a "self-rescuer" is now commercially available. It will give protection for seventy minutes in one per cent of carbon monoxide and for twenty minutes in two per cent. These concentrations are fatal to an unprotected person. At higher concentrations the heat generated by the oxidation makes the otherwise harmless air from the respirator unfit to breath. Because of this generation of heat, however, hopcalite is used in connection with thermo-couples in carbon monoxide recorders and alarm signals. These are particularly useful in vehicular tunnels and other closed places where carbon monoxide from engine exhaust or other sources is apt to accumulate.

A. S. A. E. and Related Activities

A.S.A.E. Election Results

THE annual election of officers of the American Society of Agricultural Engineers, conducted by letter ballot, has recently been completed. The officers elected will take office immediately following the 22nd annual meeting of the Society to be held at Washington, D. C., June 19 to 22, and will serve for one year. The officers elected are as follows: President, William Boss, chief, division of agricultural engineering, University of Minnesota; first vice-president, Geo. S. Knapp, chief engineer, Division of Water Resources, State of Kansas; second vice-president, W. C. Harrington, field agricultural engineer, Portland Cement Association; treasurer, Raymond Olney, secretary, A.S.A.E.; member of the Council, Geo. W. Kable, agricultural engineer, Oregon Agricultural Experiment Station; nominating committee, J. B. Davidson, Iowa State College, chairman; Dan Scoates, A. & M. College of Texas; G. W. McCuen, Ohio State University.

Dallas Selected for 1929 Annual Meeting

FOLLOWING a canvass of members of the American Society of Agricultural Engineers, as to their preference in the matter of where the 1929 annual meeting of the Society should be held, the Council of the Society has recently decided that the meeting shall be held at Dallas, Texas, where the Society will be the guest of the Southwest Section.

The canvass of members asking them to indicate a preference for Dallas, Texas, or Fayetteville, Arkansas, the two places that had extended invitations, showed a two to one preference for Dallas.

North Central Section Meeting at Ames

THE North Central Section of the American Society of Agricultural Engineers will hold a meeting at Iowa State College, Ames, May 19. An interesting program has been planned and a large attendance from college agricultural engineering departments and farm equipment manufacturing organizations is anticipated.

Those attending the meeting will assemble at the agricultural engineering building, the headquarters, late Friday afternoon for an inspection of the college buildings and grounds, with particular attention to the work in agricultural engineering.

The opening session of the meeting will be called at nine o'clock on the morning of May 19, with a discussion of the combine as the first subject on the program. In addition to the regular combine discussion attention will be given to agricultural extension projects that are needed to meet the combine situation.

Other subjects to be presented at the morning session is one on weed control by R. H. Black, Office of Grain Investigations, U. S. Department of Agriculture, and the result of research work on reinforced brick beams by Mason Vaugh, University of Missouri.

A feature of the afternoon program will be a paper by Prof. O. R. Sweeney, chemical engineer, Iowa State College, on research on corn stalks as a by-product, and E. V. Collins, agricultural engineer of the Iowa Agricultural Experiment Station, will discuss the subject of corn stalk harvesting.

There will be an inspection of research projects in agricultural engineering at Iowa State College, including the "L" concrete block, poultry house ventilation, automatic feed grinding, and other experimental machinery.

Closing the afternoon session, E. M. Mervine, of Iowa State College, will discuss the subject of teaching methods in farm machinery.

An evening session will be held which will be devoted exclusively to rural electrification, and will include such subjects as electric refrigeration, grinding feed with electric power, developing rural electric services, etc.

Major Stout Elected Honorary Member

THE election to honorary membership of Oscar Van Pelt Stout is announced by the Council of the American Society of Agricultural Engineers. Major Stout has been a member of the Society for a number of years, and it is particularly in recognition of his active interest in and support of agricultural engineering from its inception that this honor is paid to him. As stated by one of his students, Major Stout deserves a great deal more credit than he would take for the part played by him in organizing agricultural engineering work at the University of Nebraska. His record while dean of engineering at that institution in support of agricultural engineering is quite unusual in the history of agricultural engineering development in the colleges and universities of this country.

While the first department of agricultural engineering was organized at Iowa State College, work in agricultural engineering was begun prior to that time at the University of Nebraska. In these early beginnings of the work Dean Stout, as he is known to his former students, was very active in its behalf; in fact, he was the first dean to speak to the Land Grant College Association on the importance of agricultural engineering, even before it was known by that name.

Major Stout was born in Nebraska in 1865, and after graduating from the high school at Beatrice, he entered the University of Nebraska, where he received his bachelor's degree in civil engineering in 1888; in 1897 he was awarded the degree in civil engineering from that institution.

During 1886, 1887, 1888, 1889, and 1890 he was engaged in railway construction, location and maintenance work on the Burlington, Missouri Pacific, and Union Pacific railways, during part of which time he was acting division engineer on the Wyoming Division of the Union Pacific Railroad. For one and a half years in 1890 and 1891 he was city engineer of Beatrice, Nebraska, during the period of active construction of sewers, pavements, and water works extensions.

In 1891 he became associated with the University of Nebraska, serving successively as instructor, adjunct professor, associate professor, professor, and head professor of civil engineering; he was in charge of the department of civil engineerirg after 1893. He was made dean of the college of engineering of the University in 1912, which position he held until 1920.

In addition to his college duties, he was engaged in a number of outside engineering activities. From 1894 to 1904 he was resident hydrographer of the U. S. Geological Survey for Nebraska and adjoining states, which work required measuring the flow of and keeping a record on streams which might be utilized for irrigation and power purposes. From 1899 to 1910 he was connected in various capacities with the irrigation and drainage investigations of the U. S. Department of Agriculture. He surveyed 300 square miles of land in California in 1902 and prepared plans and specifications for the drainage of 20,000 acres of swamp and alkali lands.

In 1906 and 1907 he was consulting engineer in the design and construction of the Tri-State (farmers) Canal in Nebraska and appurtenant structures, including the needle dam across the North Platte River and distribution system.

From 1908 to 1910 he was consulting engineer and head of the engineering department of the Costilla Estates Development Company, Colorado Springs, San Luis and San Acacio, Colorado, the construction cost of which development amounted to $2,000,000, and consisted of canals, structures, reservoirs, etc. This work included the construction of four earth dams, the highest of which, the Sanchez (110 feet), was at the time of its construction one of the most notable earth dams in the country.

He was frequently engaged to report on irrigation projects of greater or less magnitude. One of the principal enterprises was that devoted to the reclamation of the ceded portion of the Shoshone Reservation in Wyoming at a cost

of several million dollars. He rendered service as an expert witness or engineering associate in lawsuits involving damage by floods, administration of irrigation enterprises, design of structures, design and operation of waterworks systems, in state and federal courts. He was also consulting engineer on drainage projects of various magnitude, and investigated and reported on water power projects.

The ex-officio positions which he held included that of irrigation and drainage engineer of the Nebraska Agricultural Experiment Station, and engineer of the Nebraska State Board of Agriculture.

In June 1917 he was commissioned a major in the Engineering Reserve Corps and served in various capacities in the engineering branch of the service until the end of the war.

For the past several years Major Stout has been engaged in work with the irrigation investigations division of the U. S. Department of Agriculture, with headquarters at Berkeley, California.

In honoring Major Stout by electing him an honorary member of the Society, the Council is recognizing not only the invaluable services of an eminent engineer whose early encouragement of agricultural engineering is one of the important milestones in the progress of this particular branch of engineering, but it is also honoring a delightful gentleman, one who is highly esteemed by his former students and whose worth is too little known by the engineering fraternity at large. (A picture of Major Stout and additional remarks about him and his work will be found on the "Who's Who in Agricultural Engineering" page elsewhere in this issue.)

N.E.L.A. 51st Convention

THE fifty-first annual convention and exhibition of the National Electric Light Association will be held at Million Dollar Pier, Atlantic City, New Jersey, June 4 to 8.

An even larger attendance than last year is anticipated. The 1927 convention held at the same place drew approximately ten thousand people.

An extensive exhibit of electrical appliances and equipment has been planned. The convention program will be announced at an early date.

Persons interested in attending the convention are advised to get in touch promptly with the Association headquarters at 420 Lexington Avenue, New York City, and get the convention transportation and hotel circulars.

Haymaking Symposium

WHAT is the actual status of haymaking methods in this country? Are there opportunities for increasing the efficiency of our hay making methods? Are there methods now employed in certain parts of the country which could be followed with profit in other sections? What is possible in the way of improving the design of haymaking equipment? How important is artificial drying of hay? What are some of the "failures" met with in haymaking experiments and can we help someone else to avoid them? What is known about possible new ways of handling the hay crop—lower cost—to make a better quality of hay—increased yields.

These are questions which are being asked and which it is hoped may be answered in connection with the haymaking symposium that will feature a half-day's session of the Power and Machinery Division of the American Society of Agricultural Engineers in connection with the 22nd annual meeting of the Society to be held in Washington, D. C., June 19 to 22. Engineers representing manufacturers of haymaking equipment, agricultural colleges and experiment stations, farm enterprises, etc., are being urged by the chairman of the Division to contribute any worthwhile information they have to this symposium. Practically any exact information will be useful, as well as analyses of the situation, recommendations for changes in methods, and desirable changes in machinery. It will be the aim of this symposium to discover those phases of haymaking which need most attention and to aid in the establishing of additional research projects, if such are found necessary. It is urged that those who wish to contribute to this symposium write the chairman of the Power and Machinery Division at once—L. J. Fletcher, Caterpillar Tractor Company, Peoria, Illinois.

Study Engineering Aspects of Agriculture

"THE Engineering Aspects of Agriculture" is one division of the study to be undertaken by Secretary Hoover's Committee on Recent Economic Changes in the United States.

This committee is composed of outstanding industrialists, economists, educators and engineers. It will work under the general supervision of the National Bureau of Economic Research and complement a similar study made in 1921. The American Society of Agricultural Engineers will have one or two representatives on this committee.

Data on the engineering aspects of agriculture will be collected and collated for the committee by the American Engineering Council as part of its participation in the study.

American Engineering Council will contribute to the work of the Hoover Committee in a similar manner on the subjects "Technologic Changes in Industry" and "Contrasts Between Old and New Industrial Conditions." Funds necessary for carrying on the work will be provided by the Hoover Committee.

The study is to be completed in about six months.

American Home Economics Association Meeting

FORT DES MOINES HOTEL, Des Moines, Iowa, will be the headquarters of the American Home Economics Association at its twenty-first annual meeting, June 25 to 29.

One feature of the meeting will be a trip by special train to visit Iowa State College, Ames, and especially its division of home economics, one of the oldest and largest in the country. The complete program of the meeting has not yet been announced.

Information on routes, rates, hotels, etc., can be obtained from Miss Alice L. Edwards, Executive Secretary of the Association, 617 Mills Bldg., Washington, D. C.

U.S.D.A. Report on Combines

A REPORT of the investigations of combines which were completed by the U. S. Department of Agriculture recently is published in Technical Bulletin No. 70-T, entitled "The Combined Harvester-Thresher in the Great Plains." Copies of this publication may be had free by writing the Department of Agriculture, Washington, D. C.

Ohio Student Branch Feeds Farmers

A NET profit of $174.43 to the student branch of the American Society of Agricultural Engineers at Ohio State University resulted from its efforts this year to engineer the preparation and serving of lunches to the Farmers' Week visitors who frequented the campus during the week of January 30 to February 3.

For several years this branch has operated a lunch counter in the agricultural engineering building during Farmers Week for the convenience of the many visitors to the department. Profits to the branch as a result of this activity have been generally increasing, the amount this year setting a new record.

With half a dozen other student organizations operating lunch counters at the same time, in addition to two or three regular campus cafeterias and the numerous "greasy spoons" which fringe High Street, there is keen competition for the privilege of satisfying the five to six thousand or more farm appetites which are annually transplanted to the university for this week.

The "ag-engineers" are on the job and come in for their fair share of the business. They begin to formulate their plans months ahead of time and proceed in a businesslike manner. One member of the branch is appointed as buyer and manager. A competent cook is employed and the boys all turn in and help whenever they have time off from classes. In white coats, frying 'amburgers, waiting on trade and washing and wiping dishes they don't look much like agricultural engineers. L. F. Hosbrook was presented with a Society pin for being the most faithful worker this year.

A varied menu is built up around a substantial plate lunch and many of the farmers and their wives while on the campus make eating at the "A.S.A.E. Lunch Counter" a regular thing.

Personals of A.S.A.E. Members

F. D. Cornell, Jr., instructor in farm mechanics, West Virginia University, Morgantown, is author of Circular 49, entitled "Buildings and Equipment for the Dairy Farm," recently issued by that institution.

A. J. McAdams, land reclamation specialist, Missouri College of Agriculture, is author of a bulletin, entitled "The Use of Dynamite for Ditch Blasting," recently issued by that institution.

New A.S.A.E. Members

Herman W. Allyn, superintendent, Rock River Farms, Byron, Ill.

Chas. R. Berry, secretary and treasurer, Cotton Harvester Mfg. Company, Greenville, Miss.

Robert C. Caughey, consulting engineer, J. I. Case Threshing Machine Co., Grand Detour Plow Division, Dixon, Ill.

Fred Copeland, student trainee, Oklahoma Gas and Electric Co., Shawnee, Okla.

F. R. DeForest, instructor, A. & M. College of Texas, College Station, Texas.

Cal. E. Kerr, president, Corsicana Grader & Machine Co., Corsicana, Texas.

Stanley M. Madill, designer, John Deere Plow Works, Moline, Ill.

Charles T. Meek, manager, Cooke Valley Farms, Eldred Ill.

Orie A. Potts, in charge of rural service department, Illinois Power and Light Co., Inc., Champaign, Ill.

E. W. F. Reed, general manager, tropical banana divisions, The Atlantic Fruit & Sugar Co., New York City.

Benjamin T. Rodgers, farm manager, Rodgers Agricultural Service, Hillsboro, N. D.

Carlo Santini, engineer, R. Istituto Superiore Agrario in Portici, Portici, Italy.

William S. Scarth, instructor, School of Agriculture, Claresholm, Alberta, Canada.

Transfer of Grade

Thayer Cleaver, junior agricultural engineer, U. S. Corn Borer Control, 615 Front St., Toledo, Ohio. (Student to Junior Member.)

Glenn I. Johnson, research worker, Georgia State College of Agriculture, Athens, Georgia. (Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the April issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Harold T. Baker, assistant state extension engineer, University of Nebraska, Lincoln, Neb.

Maybin S. Baker, agronomist, U. S. Dept. of Agriculture, Office of Experiment Stations, Christiansted, St. Croix, Virgin Island, U.S.A.

Geo. P. Clements, agricultural economist, Los Angeles Chamber of Commerce, Los Angeles, Calif.

George E. Grunewald, agricultural engineer, Iowa Railway and Light Corp., Blairstown, Ia.

Sydney M. Hendrickson, instructor, University of Saskatchewan, Guernsey, Sask., Canada.

A. Jensen, designing and consulting engineer for dairy equipment, Los Angeles, Calif.

Harry D. Kinney, engineer, Harvey Fisk & Sons, 120 Broadway, New York City.

Eber B. Lewis, field engineer, University of Nebraska, Lincoln, Neb.

Stanley W. McBirney, assistant agricultural engineer, U.S.D.A. European Corn Borer Control, 615 Front St., Toledo, Ohio.

Curtis L. Mosher, assistant federal reserve agent and economist, Federal Reserve Bank of Minneapolis, Minneapolis, Minn.

Willard J. Parvis, agricultural engineer, U.S.D.A. European Corn Borer Control, 615 Front St., Toledo, Ohio.

Frank L. Skelton, engineer, Continental Manufacturing Co. Springfield, Ohio.

John B. Woods, assisting in engineering research, U. S. D. A. European Corn Borer Control, 615 Front St., Toledo, Ohio.

Employment Bulletin

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members as well as members, are privileged to use the "Positions Open" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER available. Seventeen years experience in the designing and manufacture of farm tractors, motor trucks, harvesting machines, and earth-working tools. Sales experience in United States, Canada, England, France, and Italy. Write for interview. MA-132.

AGRICULTURAL ENGINEER desires position with barn equipment manufacturing company. Graduate in agricultural engineering from Iowa State College. Has had farm experience and considerable experience in designing and drafting of farm structures. Services available on thirty days notice. MA-149.

AGRICULTURAL ENGINEER, graduate in agricultural engineering, (B.S. in 1923; M.S. in 1924) desires position in experimental research work. Two years experiment station experience, five years industrial shop experience, eighteen months in employ of electric service company, one year teaching. Available upon reasonable notice. Age 27. Married. MA-142.

DESIGNING AND RESEARCH ENGINEER with experience in developing equipment and machinery for commercial field. Several years experience in commercial research. Will undertake specific projects for business desiring the solution of problems in design, performance testing, or engineering analysis. MA-145.

MECHANICAL ENGINEER with fifteen years experience in heavy line power farming and harvesting machinery, such as tractors, threshers, combines, and corn pickers and huskers, including ten years as chief engineer, desires employment with reliable and substantial manufacturer of farm equipment. Will go anywhere. MA-146.

EDITOR AND WRITER with ten years experience in farm mechanical equipment, from both trade journal and farm paper angles, specializing on promotion and technique of power farming. Qualified for publication, house organ, advertising literature, or sales promotion work involving technical accuracy and popular appeal. Farm background, college training, instructional experience. W. B. Jones, St. Joseph, Mich.

MECHANICAL AND AGRICULTURAL ENGINEER, graduate of University of Michigan, with many years experience in the design, purchasing, production, manufacture, and sale of agricultural implements, iron pumps, hand and power spray machinery, and with a wide acquaintance with manufacturers, jobbers, and dealers, desires employment with a reliable and substantial manufacturer. Will go anywhere. MA-150.

MECHANICAL ENGINEER, graduate of a New England college, with twelve years commercial drafting experience, six years in college teaching, desires position in college work. Forty-two years of age; unmarried; naturalized citizen of English birth; Protestant. Available August 1. MA-151.

Positions Open

AGRICULTURAL ENGINEER with college training and practical experience with tillage tools and seeding machinery wanted by a farm machinery manufacturer in the Middle West. Must be skilled draftsman and have designing ability. PO-132.

AGRICULTURAL ENGINEER capable of designing automatic shocking machine for commercial production from a factory model that has been successfully demonstrated in the field for four years wanted at once. Wire A. L. Marks, 407 Empire Block, Edmonton, Alberta, Canada, giving full particulars as to training, experience, references, and salary expected.

THREE ENGINEERS with several years experience in tractor design wanted by old established tractor manufacturer. Interested persons should explain experience fully, salary expected, etc. PO-134.